Collaborative Student Modelling in Foreign Language Learning

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Abstract

This thesis illustrates the potential for student models to include a richer range of information, to aid in diagnosis and to support learning. This is achieved in three ways:

- taking account of issues which affect learning in the target domain;
- involving the student in the student modelling process;
- using the student model as a learning resource for the student.

Although this is a general perspective, it is here illustrated in a concrete implementation in the domain of Second Language Acquisition. The approach is *collaborative student modelling*.

The aim of collaborative student modelling is to encourage greater learner involvement in the modelling process in order to obtain a more accurate student model, while at the same time promoting learner reflection. Reflection occurs as the student is encouraged to view the student model, and to collaborate with the system in its construction and repair. The student model here assumes some of the work conventionally associated solely with the teaching strategy module, while also becoming a learning resource. Learners are involved in the maintenance of a range of aspects of the model, which include theoretical issues in Second Language Acquisition as applicable to themselves, and the accuracy of the representations of their beliefs.

In the field of *Second Language Acquisition* this thesis makes contributions to five areas: analysis of errors with personal object pronouns in European Portuguese; transfer from non-native languages; acquisition sequence; learning strategies; language awareness.

In the field of *Artificial Intelligence in Education* the thesis has introduced the approach of collaborative student modelling as a means of increasing the accuracy of the student model, and encouraging learners to reflect on their knowledge and approaches to learning.

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Parts of this thesis have been previously published or described in the papers listed in appendix A. The work was funded by a studentship from the Economic and Social Research Council, award number R00429124033.

Finally, Walter the cat walked over the keyboard now and then, and made some interesting contributions to chapter two.

This thesis is dedicated to Geraint Wiggins,
for making sure I did it.

I hereby declare that this thesis has been composed entirely by myself, and that the research described is my own work.

Susan Bull

Contents

Chapter 1

Introduction

Learners are unpredictable

So how can you be sure that your student model is sensible?

The following are language learners' attempts at writing sentences in Portuguese[1].

For sentence 1: 'Manuel and his son would say it to him later'

Learner S9 writes: *O Manuel e o seu filho **diria-lho** mais tarde.*

Learner S10 writes: *O Manuel e o seu filho **lho diriam** mais tarde.*

Learners S3, S5, S15, S16, S19, S29, S32, S35, S42, S45 write:

*O Manuel e o seu filho **diriam-lho** mais tarde.*

Who is right? Nobody!

(The correct sentence would be *O Manuel e o seu filho **dir-lho-iam** mais tarde*)

1 European Portuguese. (There are some differences in Brazilian Portuguese.)

For sentence 2: 'Did Ana give him the book?'

Learners S3, S9, S19, S15, S29 write:

*A Ana **deu-lhe** o livro?*

Learners S5, S10, S16, S35, S42, S45 write:

*A Ana **lhe deu** o livro?*

Learner S32 writes: *A Ana **lhe-deu** o livro?*

This time the first group of learners are correct.

For sentence 3: 'The girls will see it at the cinema'

Learners S15, S16, S35, S42 write:

*As raparigas **verão-no** no cinema.*

Learners S5, S10, S19 write: *As raparigas **verão-lo** no cinema.*

Learner S32 writes: *As raparigas **verão-o** no cinema.*

Learner S9 writes: *As raparigas **verá-no** no cinema.*

Learners S3, S29 write: *As raparigas **vê-lo-ão** no cinema.*

Learner S45 writes: *As raparigas **o verão** no cinema.*

S3 and S29 are correct.

With sentence one, there is one very common error. In the second sentence there is a more even split between correct, and the most common incorrect version. Sentence three shows a wider range of difficulties.

Students' comments about their errors reveal a range of misconceptions. For example for sentence 3, S9 believed that the pronoun (*o* - or *no* as applies in this context) is post-verbal: i.e. it should come after *verão* ('will see') in the future tense, as here. S9 stated "I had completely forgotten conditional/future tenses infix their pronouns". S15 thought this was probably the present tense, so the conditional/future infixing was irrelevant. S45 thought that *verão* meant summer, and got totally confused. S3 had no difficulties with this sentence. (See appendix Bv).

How can such erratic behaviour be modelled? Can you adequately model the origins of misconceptions? Baker (1993) states that through the use of dialogue

in tutoring, other constituents of the intelligent tutoring system (ITS), for example the student model, will not need to be so accurate. Because of the difficulty of modelling learners, some researchers have claimed that, since human teachers do not usually have separate detailed models of their individual students, there is no reason why a combuter-based learning environment should (e.g. Bowerman, 1993). Laurillard (1992) argues for a teaching strategy drawn from a diagnostic process which is based on 'what the student knows', rather than from an explicit student model. Cumming et al (1994) introduce the notion of the *minimal learner model* (MLM), which represents the minimum amount of information about a learner, or about learners in general, which will enable instruction to be effective. They claim that isolating teachers' MLMs will go a long way towards identifying the most significant components for inclusion in a student model, as part of a computerised (or non-computerised) learning environment.

These approaches all have something to offer. There is no doubt, for example, that Baker's (1990) *negotiated tutoring* could overcome some of the difficulties of deciding how to proceed, if the student model is not able to fulfil this role. Identification of information contained in MLMs will also be useful. However there is at the same time no reason to assume that a more detailed student model may not also be effective. Indeed, the fact that teachers may not have detailed individual models of their students does not in itself imply that an intelligent learning environment (ILE) should not. The two situations are different. Teachers cannot be expected to hold large amounts of detailed information about everyone they teach, however a computer-based environment can, if adequate techniques are developed to support this. It is, of course, unfruitful to model information which will not be used, but there is a large amount of additional knowledge about learners which *could* be useful, if captured. Further, there may be roles for the student model beyond those conventionally strived for. In this thesis it will be shown that there is an effective use of the student model as *promoter of reflection*. This is a separate argument from that of whether learners can be modelled effectively, or whether useful adaptations can be determined from the contents of student models. The focus here is on student modelling itself, in its capacity of *learning resource*.

1.1 What are Learners Like?

Jennifer is impatient. She does not like to have to think a lot before she starts to do something. However, she also likes to get things right. This conflict often leads to frustration. Jennifer requires an approach that will let her explore, and try things out quickly. She does not want to be forced to plan. But, at the same time she must be able to have her attempts verified, to satisfy her need for correctness.

Once she has made a few attempts at a problem, which often contain errors (due to her skimming of relevant information rather than reading with attention), Jennifer becomes very focussed in working out what her difficulty is. It becomes a challenge, and she is highly motivated to continue, and adapts her way of working to fit the specific problem. Thus, although it might at first seem that she has a very ineffective orientation to problem solving, because of her flexibility, once she identifies her own weaknesses this approach works very well for her.

Some people may be horrified at Jennifer's 'jump in and give it a go' attitude; it appears to them too random. However, their own approach of careful planning and exhaustive search of all available material does not necessarily result in a quicker solution. Jennifer gets there in the end, and enjoys the journey. So, who should you design an ILE for? Jennifer or 'those other people'? Can you cater for both? And more?

One of the issues addressed in this thesis is *learning strategies*. There is no point in trying to adapt individuals towards some 'proper way of working'. The system to be presented in this thesis monitors its users' individual approaches to the tasks in the domain, with a view to suggesting strategies which might be useful *for them*, based on the combination of those they already use - if they *wish* to consider alternative approaches.

Jennifer's native language is English. She tried French at school, but did not like it. She gave it up as soon as possible. She never learnt a foreign language, and thought that she "didn't like other languages".

Other learners will be different. Most learners of Portuguese, for example, are not learning this as their first foreign language. Thus any language transfer which may occur will not necessarily come from English. The intelligent computer assisted language learning (ICALL) system of this thesis must therefore take account of the range of linguistic backgrounds its users might have.

Other differences are also expected. It is rare that two language learners will consistently make all the same mistakes as each other. Although their performance will often reveal the use of systematic rules, these rule systems can be very idiosyncratic. Some problems will, of course, be more common than others, and it is useful therefore for an ICALL system to be aware of the most common problems. However, it should also expect 'strange' things to happen. In accordance with this view, the system to be described here used an empirical study of a group of language students across a five week period, in order to gain as much knowledge as possible about what students do in the target domain. This was naturally not exhaustive - Jennifer's first error was not made by any of the students involved in the original empirical study!

However, it is not only irregularities, inconsistencies and unexpected happenings which occur in learner language. Some aspects tend to hold true across most learners. Pienemann (1985) argues that there is a typical sequence of acquisition of the target language rules. This aspect is therefore also considered in our ICALL system.

Some learners know what language is about. Jennifer initially does not - the idea of moving pronouns about depending on whether, for example, the sentence is positive or negative, or what type of question is being asked, seems odd. Indeed, the thought of pronouns "popping up in the *middle* of verbs" is quite alarming. However, Jennifer rapidly develops an awareness of what is involved as she uses the ICALL system, feeling increasingly comfortable with the explicit knowledge encountered, and reassured that she can actually generate new sentences based on the rules she has acquired. Clearly there are many learners for whom development of such language awareness would be advantageous.

This thesis aims to take account of issues influencing learning of a target domain, in student modelling, and uses the specific example of second language

acquisition. The issues covered include error types, language transfer, typical acquisition sequence, learning strategies and language awareness.

1.2 Modelling Interlanguage

The previous section provided an indication of a range of issues which must be accounted for when modelling second language learners. In part this involves securing the learner's *interlanguage* (Selinker, 1972), i.e. the individual's own set of rules which match neither the target language nor the native language rules. Selinker (1992) reviews work of other scholars, finding that, although the term interlanguage had not previously been used, it was possible to associate a kind of 'in-between language or grammar' with the claims and findings of these authors. As stated by Selinker, interlanguage was always present, it just had not been discovered.

In essence, any foreign language student model which contains sufficient (and appropriate) information will be modelling interlanguage, though this is usually not claimed explicitly by the authors of ICALL systems (sometimes because they are unaware of the literature and notion of interlanguage). A system proposed by Schuster and Burckett-Picker (1995) does use this term, though the aim of their system is claimed to be for the intelligent tutoring system 'to transform the student model into something which more closely resembles the L_2 [target foreign language]'. There is a sense in which this could be said to be true of most ICALL systems containing a student model, though it is unclear whether the description of an *ITS transforming the student model* would be acceptable; presumably a system aims to facilitate learning in some manner, and it is this *resulting learning*, manifested in *improved performance* (which does indeed occur after some kind of influence from the system), which *leads to* transformations in the student model.

This thesis describes a student model which was designed largely around the notion of interlanguage. It encompasses a sequence of models reflecting a learner's developing interlanguage. This involves a knowledge of some of the issues introduced above: the typical sequence of acquisition of most learners; information about a wide range of error types which can occur; and a knowledge of other

languages known by the target users. In addition it takes into account individual learning strategies and aims to promote language awareness.

1.3 Collaborative Student Modelling

Collaborative student modelling as presented in this thesis implies the student and system working together, towards the construction of a student model which reflects the two parties' joint evaluation of the student's knowledge. This approach was developed partly as a result of the desire to help develop language awareness through prompting reflection, and partly through the aim of increasing the accuracy of the student model. In collaborative student modelling, each of these functions supports the other.

Collaborative student modelling could be used in conjunction with any successful modelling approach.

1.3.1 The Domain of Illustration

The domain of the current implementation is very restricted. Although a large variety of problems can occur, there are only twelve target rules in the ICALL system. It is obviously a lot easier to build a student model when the domain is limited, since, as the domain to be acquired widens, so do potential combinations of possible misconceptions, etc. The collaborative student modelling approach is a step towards providing a method for modelling in broader target domains. Thus, although currently restricted, extending collaborative maintenance of the model should be less difficult than trying to infer complete student models for large or complex domains.

The method presented here is an example illustrating that collaborative modelling *can be achieved*, and further, this is not with detriment to learning as the collaboration is partly aimed at *promoting reflection*.

1.3.2 Promoting Reflection

Reflection is expected to occur as a result of the collaborative modelling process, since students are required to explain and justify their views, providing a vehicle through which they may practise *self-explanation*. This differs somewhat from Chi et al's (1989) well known experiment on self-explanation, for although our students may be trying to explain correct domain examples as in Chi et al's study, they may also be defending their own (mistaken) beliefs. Therefore, in addition to reflection on domain knowledge, students also reflect on, and become more aware of, their learning and possible difficulties in the domain (and indeed, possibly also their own approaches to learning in general).

1.3.3 Will this Approach Work for Everyone?

We saw in section 1.1 that there are a variety of features to consider when trying to model an individual learner. Some learners are more successful than others, but we cannot assume this to necessarily be a result of their approaches to the task. It may well be true that in general, learners who generate self-explanations of the material presented tend to do better (Chi et al, 1989), but this does not imply that *all* learners would become better if they were forced to adopt this approach from the outset. Jennifer, for example, has a very strong resistance to deliberating about a problem before trying to solve it. However, once she meets difficulties she identifies the problem and proceeds to explain her mistake to herself. This is almost the reverse of what is usually assumed by self-explanation in an educational context. Jennifer has been doing this all her life, and it is not clear whether for her an attempt to change her way of working towards a more 'positive' manifestation of self-explanation would be useful. Of course it might, and the possibility of making alternative approaches apparent may be beneficial, but since it also *might not*, we do not want to direct Jennifer or other learners towards some pre-specified way of working.

The equivalent must, therefore, also be said of the collaborative modelling approach proposed in this thesis. Not everyone will want to discuss their beliefs with the system, therefore this must not be a requirement of the interaction. We

claim here only that this method, if taken up by a student, will help the system to model that student more accurately, and it is also likely to further learning by promoting reflection on the part of the student. This approach, as in the current ICALL system, will certainly suit the type of learner who wishes to 'learn about the language' (Wenden, 1987), and it is reminiscent of the notion of the 'learner as researcher' as recommended by Wolff (1994). It has also been shown to suit Jennifer - a non-planner not used to seeking out information before commencing problem solving. It is therefore hoped that collaborative student modelling may suit different types of learner, possibly through different kinds of interaction. There will always be some learners who dislike such an explicit approach, but these students are often those who are less concerned with achieving a high level of accuracy, favouring communication above correct production[2]. As this type of student is not the main intended user, this is not of great concern here. It is anticipated that this approach will be very useful for at least a large group of learners.

1.3.4 Is Collaborative Student Modelling Generalisable?

In this thesis the example domain is second language acquisition. The issues to be discussed for our Portuguese domain will obviously also be relevant for many other language areas. The crucial question, therefore, is whether collaborative student modelling as described here is generalisable to non-language domains.

The existence of a negotiated model is easy to envisage in a different domain. However, some of the language issues need to be considered for their relevance to other subjects. In Bull et al (1995a) we suggested ways in which the points covered in our ICALL approach could be incorporated into different subject areas; in particular, learning about electrical circuits. We do not claim that the issues to address in other domains will necessarily be identical, or equally important, but that each instantiation of the student model should take into account the relevant issues for learning in its target domain. Assuming this is undertaken, the approach of collaborative student model should be generalisable. (Collaborative student modelling would also be possible if specific domain issues were ignored, but the

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[2] This is not to say that learners striving for accuracy are not concerned with effective communication, but rather, some language learners are satisfied with effective communication regardless of whether their language is syntactically correct.

student model would inevitably be less powerful.)

1.4 Empirical Studies

Since domain issues are important in this approach, several empirical studies were conducted to determine what should be included in this particular implementation. These are listed below, and described in more detail in chapter 4[3].

STUDY 1:	Pronoun errors & acquisition sequence
STUDY 2:	Transfer to Portuguese: perceptions
STUDY 3:	Transfer to Portuguese: performance
STUDY 4:	Evaluation of learner profile: transfer & learning strategies
STUDY 5:	Reported use of learning strategies
STUDY 6:	What is negotiation?
STUDY 7:	Can students state their confidence in their input?
STUDY 8:	Can students identify their misconceptions?
STUDY 9:	Do students inspect and challenge their student model?

The first five studies relate to the language issues covered in this thesis, and the latter four to collaborative student modelling in general.

1.5 Abbreviations

A few abbreviations are used in this thesis. For convenience of reference these are given below.

CALL	*C*omputer *A*ssisted *L*anguage *L*earning
DO	*D*irect *O*bject

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[3] These studies have also been presented in the following publications: STUDY 1: Bull (1994a); STUDY 2: Bull et al (1995a); STUDY 3: Bull (1995); STUDY 4: Bull et al (1993); STUDY 7: Bull et al (1995b); STUDY 8: Bull (1994a); STUDY 9: Bull & Pain (1995).

EFL	*E*nglish as a *F*oreign *L*anguage
ICALL	*I*ntelligent *C*omputer *A*ssisted *L*anguage *L*earning
IL	*Inter*language
ILE	*I*ntelligent *L*earning *E*nvironment
IO	*I*ndirect *O*bject
ITS	*I*ntelligent *T*utoring *S*ystem
L_1	native language
L_2	a foreign language
L_3	a foreign language which is not the first foreign language
Mr. Collins	*Coll*aboratively constructed, *ins*pectable student model
SLA	*S*econd *L*anguage *A*cquisition

1.6 What happened to Jennifer?

By the end of this thesis Jennifer will no longer seem so unpredictable. She is learner B2, and can be found in section 4.6.6 and chapter 5.

1.7 Structure of the Thesis

Chapters 2 and 3 describe the literature on the issues introduced above, which served as a basis for the design principles for our student model. Chapter 2 deals with second language acquisition, and chapter 3 with approaches to date which have exhibited some of the features of *collaborative student modelling*. The student model presented in this thesis is called Mr. Collins - a *coll*aboratively constructed, *ins*pectable student model. The implementation of Mr. Collins is described in chapter 4, and an example of Mr. Collins in use is given in chapter 5. Discussion of Mr. Collins, including limitations and further work, occurs in chapter 6.

The preface to the third edition of the Swedish volume of the *Teach Yourself* series suggests that the learner might like to 'get in touch with Swedish seamen' (McClean, 1969). This thesis has no such adventurous recommendation, but its

structure should serve to address the linguistic and the implementation issues clearly, and describe the integration of these in Mr. Collins to demonstrate how future learners may receive effective help.

Chapter 2

Improving the Student Model: representing *how* students learn the domain

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The same class, taught by the same teacher using the same books, will apparently learn many different versions of the target language.

(Swann, 1986:4-1)

The above quotation illustrates the problems faced by language teachers; even though students of any one particular class are likely to have many aspects of their learning in common, there is likely also to be wide individual variation. This part of the thesis, concerned with language learning issues, seeks to address this problem in terms of its relevance to ICALL. Also considered are factors which the target users are likely to have in common. The issues addressed are:

1. a consideration of the range of error types made by target users of the system;
2. the potential influence of learners' native and other foreign languages on their learning of Portuguese;
3. the typical route of acquisition of the target rules;
4. different individual approaches to the task of language learning, i.e. learning strategies;
5. fostering language awareness.

Although this is not an exhaustive list, inclusion of a consideration of such issues in the design of ICALL is an important step forward. It can be seen that the issues surrounding the learning process which are to be focused on here take both an individualised, and where appropriate, a stereotypical view. In this chapter, these aspects of language learning and their consideration in the design and implementation of CALL to date, will be described.

Frankenberg-Garcia et al (1994) conducted a worldwide survey of students learning Portuguese, and found from respondents that CALL was viewed as the least effective means through which to learn a language. However, there is no indication of the type of programs experienced by the learners, and exactly what it

was that was regarded as ineffective, and why. Hence we may overlook this criticism: as indicated above we are dealing here with a program designed to enhance learner awareness of the language and language learning, through a better understanding of student problems. It is probable that the majority of learners in the study of Frankenberg-Garcia et al would not have encountered this type of approach.

2.1 Performance in the Target Language

There is a great deal of easily available literature in the field of applied linguistics describing, among other issues, the types of error typically made by different groups of learner. It is not the aim here to summarise all such studies and descriptions; those relevant to any particular ICALL system will depend on the actual domain, task, target users, etc. The important point is that in order to create an effective system it is useful to know the typical problems encountered by the target learners. Laurillard (1991) states that since foreign language learners in a classroom context sometimes create their own rules, these rules could be discovered by conducting empirical studies - the results of which could then be taken into account in language teaching and CALL. Chanier et al (1992) propose improving student modelling through the provision of a method to describe the rule systems created by learners, and the strategies applied in their application and use. However, although there are difficulties common to many learners from a particular group, and although the rules created by students are often systematic, this may not always be the case. Furthermore, even when the rule systems are highly systematic not all students will be creating the same rule systems. (See section 4.1.)

The available literature can be used as a starting point for designers of ICALL systems, or, if an existing study addresses exactly the problem(s) to be handled in the program, it may be used directly. Background empirical work is, of course, an ambitious undertaking if the area to be covered by a system is extensive, but even a limited understanding of probable errors is likely to lead to a more effective system. This applies also to complex ICALL systems which use, for example, machine learning techniques to generate the error representations for the student model (e.g. Sentance, 1993), since a knowledge of likely errors would supplement the information available to the system: where there are two or more

probable candidate representations for the student model such information may help the system to decide which is most likely to be appropriate, if all other methods of conflict resolution have failed to identify a single, strong candidate. There is no guarantee that inclusion of information about typical learner errors will always result in resolution of competing representations, however it does at least provide an additional perspective from which the system can consider the alternatives. For systems based around a mal-rule approach, such error analyses will be invaluable.

If there are no available or adequate studies of a type relevant to the particular system, the designers may perform an error analysis themselves. Although analysis of data collected may take some time if the study is extensive, the actual data collection phase is not difficult if there are appropriate students available. In this section error analysis is briefly described, some systems are presented whose designs were based on the results of error analyses, and pointers towards design issues for our system, to be based partly on results of an error analysis, are then presented.

2.1.1 Is Error Analysis Appropriate?

Error analysis can be used to discover *what* errors occur, and to help explain *why* they may occur. In the context of this thesis, error analysis is viewed as a means of identifying and understanding typical errors as a method of enriching the information available to the system in resolving conflicts in the student modelling process. We are referring to observed errors and initial (manual) analysis of corpora, and not using the term in relation to system analysis of learner input. Previous error analysis should not be the only method of conflict resolution used, but it can comprise a *contribution towards* identifying and understanding the causes of certain problems for ICALL. As one of several components assisting in diagnosis it is thereby able to withstand criticisms such as its focus on errors while ignoring successful performance, and the inability of error analysis to take account of avoidance strategies (see Schachter, 1974). Errors are viewed as an inevitable part of SLA, and, as such, should not be seen as negative, undesirable manifestations in interlanguage. They should be accepted as a normal part of learning. Thus the term 'error analysis' should be read with this in mind. It is one of several approaches embodied in the system to be discussed, and due to its focus

on real language data, has a useful contribution in terms of the identification and explanation of real problems faced by real learners.

2.1.2 Other Systems based on Empirical Data

A consideration of empirical data is surprisingly absent from the design phase of the majority of CALL programs. Even some systems claiming to have a more theoretical justification appear to have overlooked the benefits of some type of error analysis, for example VP^2 (Schuster, 1986). VP^2 is based on the contrastive analysis hypothesis, which although able to predict many of the L_2 errors which occur based on a comparison with the L_1, it also overpredicts - i.e. it predicts errors which are not found in learners' interlanguage. A contrastive analysis is useful for VP^2 as it is concerned solely with problems of negative language transfer, however for systems of this type an error analysis could help to clarify which errors are really likely to appear in the interlanguage of the particular group of learners for whom the system is designed.

Ghemri (1992) claims that in order to be maximally useful, systems should be based on theories which are not restricted to a particular language. Ghemri argues for the use of Government and Binding theory, as this defines all languages according to certain principles, with parameters to account for differences between languages. While a language independent architecture is a good idea in terms of its reusability, this is not necessarily a reason to avoid empirical studies relating to particular languages; although the author states that use of a general theory is an alternative to constructing a system according to specific learner data, the generality need not exclude some degree of language specific information - the two approaches do not have to be contradictory. For example, it may be helpful to know the relative frequencies of different problems encountered in a particular language. Such knowledge can also be used to lead learners towards greater awareness of typical errors, and thus illustrate that errors are *expected*, and can sometimes be an indication of *progress*.

Some authors have used empirical studies of learner data to inform the design of CALL systems. An interesting example is *ArtCheck* (Sentance, 1993), where extensive consultation of, and execution of empirical studies was performed. However, as will be shown below, the results of these investigations

were not used to aid diagnosis. *ArtCheck* is an ICALL system designed to remediate errors in the usage of English articles. Sentance referred to the study of Herranen (1978) to discover the common errors made by native Finnish speakers learning this domain. Two further studies were then carried out, to compare this data with that of Herranen. She concludes that article usage is particularly difficult for learners of languages such as Finnish, which do not have articles. These problems occur even amongst advanced learners.

Because the *ArtCheck* system was designed to illustrate the possibilities of dynamic student modelling in ICALL, Sentance's focus was not on the identification of typical problems encountered in order to design useful malrules (for example), but more to identify that article usage is a significant problem for many learners, and using this to justify the choice of domain. We would argue also that such information could be invaluable to the system too, if simply for the fact that it then has more information available on which to draw when making decisions. Such information is not the sole, nor even necessarily the main source of knowledge, but, as argued above, it can be a useful supplement.

Similarly, Liou (1993) proposes an ITS for English writing revision, which is based on the results of research projects. An error analysis was carried out on Chinese EFL student compositions, the errors found then to be considered for treatment by computer depending on their frequency and inhibition of comprehension. This system has still not been implemented (Liou, personal communication), though if it is, the research conducted so far will be used as a starting point.

Some systems have used the results of empirical studies or error analyses to inform their design and also their functioning, i.e. the system will know about the errors identified from these studies. A few examples will be briefly presented below, as an indication of the feasibility of such an approach. For many of these the effectiveness in terms of learning outcome is not known, as no system evaluation is described.

In some cases prior analyses by other researchers are used; e.g. for the representation of grammatical error rules in the student model of HELEN, a system

for English (Kunichika et al, 1993), an error analysis by Ono and Miyata (1989) was consulted.

Other researchers have conducted their own investigations. Suri and McCoy (1993) studied discourse level errors commonly made by signers of American Sign Language, when writing English. The authors were able to explain the errors found, which led to the proposal of using a local focus tracking algorithm to identify and correct some of the errors made, based on this analysis.

Maritxalar and Díaz de Ilarraza (1994) have been working with teachers in a language school to study language deviations and the production of these deviations by learners. The aim is to eventually implement an ICALL system which is adaptable and can be language independent, though current work centres on Spanish speakers learning Basque. Whichever combinations of languages are to be considered in the future, it is assumed that some study of learner errors will previously have taken place.

Swann (1986) also worked with language teachers to identify the interlanguage of Italian pupils learning English. 19 Italian to English translation sentences formed the basis of a pre- and post-test, with a nine month interval between the two. 25 students were involved in the study (an initial trial of the CAGE English grammar program). The results of the testing were used to determine implications for the design of CALL software, with a view to defining a more intelligent version of the drill and practice program.

Mulligan and Ryan (1991) designed and implemented a prototype style-checker for declarative sentences for native German speakers learning English. The six error types handled are explicitly encoded in the system, and based on results of error analysis. This included typical German-based errors and also more general errors.

Manning (1991a) conducted an error analysis of gender and gender agreement in French. She found that students often did not use the target language rules, and also constructed their own rules. There were also cases of misapplication of rules and language transfer. Formalisation of the rules obtained from learners, into a CALL program, followed.

The Chinese Tutor (Wang & Garigliano, 1995) is a prototype system for English-speaking university learners of Chinese. The system is based on results of empirical studies to identify common errors, the stages of learning at which the various errors occur, and the types of error which occur (Wang & Garigliano, 1992). Negative transfer accounted for most problems (though transfer was only considered from the point of view of the L_1 - see section 4.2.1). Because of this influence of native language transfer, errors are identified by the system through use of a mixed grammar of Chinese and English.

Chanier and Renié (1993) claim that real data from the acquisition of both L_1 and L_2 learners is necessary to supplement information in the student model. They expect to be able to obtain information on the stages of acquisition of French interrogatives, and also identify the types of problem encountered by learners. This will lead to the construction of stereotypes to be used by the learner module.

Chanier et al (1990) describe an interface aimed at aiding in the construction of a catalogue of *applicable rules* (i.e. rules likely to apply to a student at that student's stage of learning). The applicable rules are obtained after analysis of incorrect sentences previously collected from students. Both teachers and students may view applicable rules and attempt to explain the errors contained within. Once these errors have been explained in this way, rules can be defined and subsequently implemented in a system to provide information for student modelling.

A slightly different perspective is offered by MARPLE (Teutsch & Vivet, 1993). MARPLE is a system designed to evaluate students' performance in English; an evaluation which can subsequently be used by a student as the basis for discussion with his teacher. Use of MARPLE will provide knowledge of the type of answers given by trainees, which will allow the further construction of model answers - i.e. development is iterative, depending on results of the system's use. Development of advice on appropriate available remediation resources will then also be possible.

Lessard et al (1992; 1994) undertook an extensive analysis of the French L_2 texts of native English-speaking learners. The ultimate aim is to be able to use such information in an interactive teaching environment. However the initial focus is on

modelling learner language in VINCI (a natural language generation system). This can occur in two ways: 1. implementing a grammar believed to represent the grammar of a group of language learners, and testing whether system output correlates with observed data; 2. using an interactive environment to elicit L_2 utterances, and comparing these with the corpus-inspired computerized hypotheses (Lessard et al, 1992). If performance errors can be successfully modelled in this way, based on hypotheses or theories, this can be used in future cognitive modelling.

Despite the fact that the majority of CALL programs are not based on real data, it can be seen that some researchers recognise the advantages of consulting or carrying out empirical studies. In accordance with this view, in the next section the implications for the Mr. Collins student model will be described.

2.1.3 Implications for Mr. Collins

As described previously, Mr. Collins is the student model component of an ILE. The example domain of illustration is clitic pronouns in European Portuguese, thus an error analysis of this area of language will enable identification of problems of pronoun usage experienced by learners, and the relative frequency of their occurrence. As many errors produced by students are based on systematic rules constructed by the students themselves, a system with a knowledge of this kind of manifestation will be in a better position to help learners overcome problems encountered. Similarly, any less systematic, but nevertheless relatively common error types explicitly known by the system can ease the burden of diagnosis.

However, although useful the error analysis should not form the sole theoretical base of a system. This is because, due to its focus on errors, performance as a whole (including the importance of errors in learning), is not necessarily accounted for. The role of error analysis should remain in perspective, i.e. co-exist with other theoretical approaches in the system.

Errors found to be common amongst the target users can be used as a foundation for the construction of stereotypical information for the student model. However, recall that error analysis should only *contribute* information to assist in diagnosis, and not be the only source of knowledge. Therefore stereotypes based

on recorded error data should not be the only information available for student modelling. (This applies not only because error analysis cannot account for everything, but also because individuals will vary, and because of the nature of learning, students will not always easily fit stereotypes.)

This section has argued that empirical investigations of target language errors can significantly improve the system's understanding of its users. A related question is the extent to which learners' background languages can influence their performance. There is much empirical work on language transfer, and it is to this that we turn now.

2.2 Language Transfer

Not all errors made by language learners are the result of overgeneralisation of target language forms, or erroneous 'guessing' on the part of the learner. Some errors are due to (conscious or unconscious) transfer from another language. Cross-linguistic influence can in some cases be unfavourable, resulting in negative transfer, and in other cases facilitative, i.e. transfer will result in the correct form being produced in the target language. Transfer from native languages has been well documented (see Odlin, 1989 for an overview). However in some circumstances transfer may arise as a result of reference to other *foreign* languages known by a student. This non-native transfer has in general received much less attention from researchers. It is this issue which is important here: i.e. which of a learner's languages (including native) will he transfer from?

2.2.1 Non-Native Language Transfer

Examples of transfer are provided by Rivers (1983), who identified the influence of other languages in her learning of Spanish as a foreign language. This influence came not only from her native English, but also to varying degrees from four other previously learnt foreign languages (French, German, Italian and Latin). Transfer was in some cases a result of conscious attempts to facilitate acquisition through comparison with these other languages, and sometimes occurred without deliberate contemplation. Singleton (1987) describes a learner whose transfer into French came more often from his non-native Spanish than from his native English.

Similarly, Kellerman (1977) noted the effect of his non-native German on his early use of Dutch, and later, the occasional interference of Dutch in his French. The present author experienced lexical and word order influence from intermediate L_2 Spanish to beginner-level L_3 Portuguese, and also L_3 Portuguese lexical influence in L_2 Spanish. The direction of transfer depended on which of the languages had recently been studied or used most frequently (i.e. the language more commonly used at the time tended to affect the one used less frequently). A similar situation occurred with non-native Arabic to Spanish, and Spanish to Arabic lexical influence. More general examples of non-native transfer include a greater tendency towards L_2 English transfer to L_3 French, than for transfer from the L_1 Igbo to the French of Nigerians (Ahukanna et al, 1981), and the appearance of English word order in the Swedish and German of some Finns (Ringbom, 1987). We conclude that on occasions transfer may be more likely to occur from another foreign language than from the learner's native tongue. Odlin (1989) offers the following working definition:

> Transfer is the influence resulting from similarities and differences between the target language and any other language that has been previously (and perhaps imperfectly) acquired.
>
> Odlin (1989: 27)

With this in mind, we will now consider in greater detail the case of L_1-English, L_2-Spanish and L_3-Portuguese, as this is highly relevant for the ICALL system described in this thesis.

Azevedo (1978) states that due to their knowledge of Spanish as a foreign language, students in the U.S. often exhibit transfer from L_2 Spanish in their L_3 Portuguese. Azevedo encourages direct comparison between Spanish and Portuguese in the teaching of Portuguese, to help reduce negative interference and to promote positive transfer. Similarly, Chandler (1958) urges those familiar with Spanish to investigate Portuguese through Spanish, offering explicit comparisons of orthographic variations.

The rules for pronoun placement in European Portuguese, the domain of the ICALL system, are presented below (as described in Benson, 1989; 1990):

1a. The clitic pronoun is *post-verbal* in:

affirmative, declarative main clauses

yes/no questions

The same occurs in English, the reverse in Spanish (i.e. the pronoun is pre-verbal in Spanish).

1b. The clitic pronoun is *post-verbal* with:

gerunds

infinitives

positive imperatives

The same occurs in both English and Spanish.

2. The clitic pronoun is *pre-verbal* in:

negatives

open questions

after certain adverbial phrases (e.g. 'já', 'logo')

embedded clauses

The same occurs in Spanish, the reverse in English.

3. The clitic pronoun is *between:*

auxiliary and past participle

This is different from both English and Spanish.

4. The clitic pronoun becomes an *infix* between the infinitive stem and verb ending in:

future tense

conditional tense

This is different from both English and Spanish.

Benson's work is very relevant to this discussion, as she aims to identify the extent of L_1 (English) and L_2 (Spanish) transfer to L_3 (Portuguese). That part of Mr. Collins which is concerned with transfer was designed based partly on the above rules of pronoun placement. Benson (1990) predicts that with the first rule (1a), negative transfer from Spanish would be possible, resulting in pre-verbal placement of the clitic pronoun. Correct placement could be due to positive transfer from English *or* target rule acquisition. In the case of rule 2, Benson explains

correct pronoun placement with reference to target rule acquisition *or* positive transfer from Spanish, and incorrect placement could be a result of faulty analogy with English. (Incorrect placement could, of course, also occur as a result of inappropriate overgeneralisation.) Rules 1b, 3 and 4 do not permit the same possibilities for the comparison of transfer from English and Spanish, though they do not interfere with data from the other rules.

In her study, Benson (1989) suggests that Spanish (as L_2) might be responsible for a greater proportion of the answers to her test questions[1] than English (L_1) - regardless of whether the responses were correct or incorrect. Benson identifies three groups of students: 11 who scored 100%, and may therefore have fully acquired and automatized the rules concerned and, if so, were not relying on their knowledge of another language at all; 9 who had correct responses where the rules of Spanish and Portuguese are identical, but who responded incorrectly where these rules differed (and reference to English would have been facilitative); 7 students who relied primarily on English (with 100% accuracy where English coincides with Portuguese and Spanish does not, and only 60% accuracy where the Spanish rule matches Portuguese, but English does not). This could suggest that different students used different transfer strategies, though Benson was unable to seek explanations of this as the tasks were performed anonymously.

This section has demonstrated the importance of considering transfer from non-native languages in addition to native languages. The following section introduces previous ICALL systems which have been concerned with transfer.

2.2.2 Other Systems Concerned with Transfer

Most CALL programs have not attempted to deal with cross-linguistic influence. Nevertheless, the existence of language transfer has been considered and incorporated into the design of a number of ICALL systems: examples include the Automated German Tutor (Weischedel et al, 1978); Intelligent Language Tutoring System (Schwind, 1990). However these systems are limited as they have no

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1 These test questions were 1. grammaticality judgement questions; 2. insertion of given pronouns into the correct position in a sentence.

separate representation of background languages, and therefore require all transfer errors to be anticipated.

Some ICALL systems do contain models of the L_1, e.g. Catt and Hirst's Scripsi (1990) and Schuster's VP^2 (1986). However VP^2 has no model of the learner beyond the rules of the native language, and therefore is only able to detect errors from this source, and Scripsi deals only with errors of overgeneralisation and transfer from the L_1. Wang and Garigliano's (1992) system also includes a model of the native language. Their system is based on the belief that translation exercises are one of the most powerful methods of minimising negative language transfer. While this is possibly true, as translation will reduce the student's avoidance of structures of which he is unsure, this approach must be used with caution as it could lead to greater dependency on a general translation strategy, a strategy which is less efficient for communication due to its reliance on the L_1. The VP^2 system is also based on translation exercises.

The importance of considering multiple background languages as potential sources of transfer was demonstrated in the previous section. Although Scripsi can be adapted for either French or Chinese learners of English, it does not appear that both languages can be taken into account as possible sources of transfer for an individual learner. Similarly, for VP^2 it is claimed that the model of a learner's mother tongue could very easily be substituted by a different language as the native language, should the system be further developed. Again there appears to be no consideration of multiple background languages as the sources of transfer for a single learner. Wang and Garigliano's system also relies on only one language being the origin of transfer errors. The authors justified their approach through the study of empirical data which revealed transfer to be the source of the majority of errors made by their students of Chinese. However transfer was defined as "the influence of the students' mother tongue". It may be that in this case English really is the only source of transfer for these learners or, if not, transfer from other languages is minimal, but it is not clear whether the possibility of transfer from other foreign languages has been considered. In systems such as those of Weischedel et al and Schwind, which do not contain separate models of the L_1, a similar approach of 'native language only' is taken.

We are not trying to claim that the above systems cannot be useful. In many cases the L_1 *will* be the dominant source of transfer. However, there is evidence that other L_2s can also be a significant source of cross-linguistic influence. In some cases L_2 transfer may be more frequent, or may co-exist with L_1 transfer. Thus, as systems claiming to deal with transfer, those described in this section may have restricted their efficiency by not considering this possibility.

2.2.3 Implications for Mr. Collins

Section 2.2.1 demonstrated that some learners transfer from another L_2 when learning a foreign language. However, section 2.2.2 showed that ICALL programs which deal with the question of language transfer do not, in fact, allow for transfer from another *foreign* language. It is clear that this should at least be considered when designing a system to handle transfer. From Benson's (1989) data we can conclude that for pronoun placement in European Portuguese, the question of L_2 transfer is very relevant. While Spanish seems an obvious language to include in a system for learning Portuguese, other languages should also be considered as potential sources of transfer if the ICALL system is to be comprehensive in this regard, and relevant to the majority of learners. It is clear that not all possible languages can be included, however a survey of target users is required to determine the common features of their language backgrounds.

It was also stated that other languages included in an ICALL system should be modelled separately. Thus, for each language identified to be relevant for Mr. Collins, an independent representation should be constructed. Such multiple representations of background language information naturally requires an appropriate method of selecting between alternative potential candidates as sources of transfer, to ensure that the correct source is the one which is identified.

Finally, not all problems will have transfer as their cause. Therefore, the part of the system dealing with cross-linguistic influence must be appropriately integrated into the system as a whole, and only be called upon when it is believed that transfer has occurred, or when it may be useful to suggest the use of positive transfer to a student who is having difficulty with a particular rule which is, in fact, identical to the equivalent rule in one of the other languages already known (to a reasonable level of proficiency) by that student.

Section 2.2 has examined research on native versus non-native language transfer, and discovered this to be a question largely ignored in the literature. ICALL systems likewise tend to ignore this distinction. However, the importance of this question has been demonstrated. The next section looks at the acquisition order of the target rules, and discovers that this issue is similarly often avoided by designers of ICALL systems.

2.3 Acquisition Order of the Target Rules

There is more research on acquisition sequences than on transfer from multiple languages, though this research is far from conclusive. A number of studies are summarised below, however it is found that few CALL programs take account of this issue. Based on the available research in applied linguistics, the implications for the design of Mr. Collins are discussed, and also the suitability of the use of sequencing as employed in other systems outside the language domain are considered for their appropriacy for this language system.

2.3.1 Acquisition Order for L_2 Rules

Burt and Dulay (1980) remind readers of the difference between acquisition sequences and acquisition hierarchies; the former referring to successive linear orderings of *single* structures, and the latter to the acquisition of successive *groups* of structures. Both are described in the literature as acquisition orders. Some authors (e.g. Larsen-Freeman, 1976; Anderson, 1978) describe *difficulty* orders, or *accuracy* orders. As the concern of this thesis is not with 'acquisition orders' per se, but rather, how these could potentially be employed in student modelling in order to aid diagnosis, this issue is not investigated further here. In describing the literature the terms will be used interchangeably.

There is evidence that formal instruction of developmental features will facilitate language acquisition only if the learner is at the right stage in the acquisition process, for assimilation of the particular element of language to be taught (Pienemann, 1989). Pienemann (1985) summarises an experiment in which 10 learners who were at either stage X or X + 1 in the developmental sequence (in

German), were taught a structure from stage X + 2. Although both groups were able to perform the task at the time of instruction, only those at stage X + 1 were subsequently observed to produce this form in their speech. Pienemann states:

> Since the instruction was identical for both groups of learners, the differing effect of instruction on the interlanguage system was concluded to have been due to the current stage of the informants' interlanguages.
>
> Pienemann (1985: 36)

A similar conclusion is discussed in Pienemann (1987). However, Long (1985) criticises Pienemann's proposal based upon these findings, for, among other things, its claim that learners could be grouped relative to their stage of acquisition in order for instruction to be useful; Long asserts that learners at one stage for a particular structure will not necessarily be at the same stage in the acquisition of other structures. Lightbown (1985) raises the question of how long such groups would remain homogeneous, as the *rate* of acquisition can vary considerably. However, in the current context of Mr. Collins, these criticisms do not have to be addressed; the ICALL system is designed to be used on a one-to-one basis, with a different student model for each student. Comparably, Krashen's (1982) criticism that structural syllabuses are inappropriate for many learners (as they will not all be at the same level) in terms of their developmental levels in classroom instruction, is also not relevant. Lightbown's (1985) criticism of Pienemann's proposal to sequence material in the order in which it would be acquired in a natural environment is similarly not relevant in our context. Lightbown's criticism is based partly on the fact that learners in natural settings are exposed to a wide variety of language, much of which is beyond their current processing capabilities. Currently the aim for Mr. Collins is to investigate acquisition in a formal setting, where there is likely to be little informal outside contact with the target language; a situation common to the main background empirical study and the context for which the system is primarily designed. For the adoption of the design of the system into a wider context, this issue may need to be reconsidered.

As does Pienemann, Perkins and Larsen Freeman (1975) also suggest that the sequence of acquisition is not altered by formal instruction. Lightbown (1987) concludes that input data is not necessarily processed by learners in the manner in which the producer of such input would expect. Pienemann (1985) therefore advocates replacing syllabuses based on intuition by *learnable syllabuses* derived from the *teachability hypothesis* (i.e. for non-variable features, the student must be

at the appropriate stage for instruction to be successful). Learners should be introduced to forms at the right *stage* in their learning, but additional deviant production (which may result from attempting the target rule) should be allowed if learners are not yet at a stage at which this can be successfully processed.

Wode (1981) discusses developmental sequences of negation, phonology and inflection of four German children acquiring L_2 English in a naturalistic setting. Dulay and Burt (1973) found a similar acquisition sequence for 8 English grammatical functors (i.e. morphemes) by 3 different groups of 5-8 year old Spanish speaking children. The acquisition of 11 grammatical functors in English was found to follow very similar sequences for both Spanish and Chinese speaking children in a naturalistic setting (Dulay & Burt, 1974).

As can be seen, much of the work has focussed on *child* L_2 acquisition, however some research has also been concerned with *adults;* Bailey et al (1974) found comparable results in adult acquisition as were found by Dulay and Burt (1973) for children. Dickerson (1975) discovered similarities in the acquisition over time of the English sound system amongst Japanese adults. Anderson (1978) describes a common order of difficulty for sentential complementation in English. Hyltenstam (1977) identified a single interlanguage continuum for Swedish negation for all of his 160 (adult) subjects, regardless of their native languages, and Krashen et al (1976) also identified a similar acquisition sequence for adults of varying L_1s. Furthermore, Hyltenstam (1977) states that backsliders (i.e. those learners less advanced at Time II than they were at Time I), adhered to the acquisition continuum; they moved backwards *along the continuum.* Selinker (1972) states:

> backsliding by second-language learners from a TL [target language] norm is not . . . either random or toward the speaker's NL [native language], but toward an IL [interlanguage] norm.
>
> Selinker (1972: 215-216)

Not all research has revealed the same sequencing; the two above mentioned studies by Dulay and Burt do not describe identical acquisition orders. Hakuta (1976) describes a different sequence of acquisition of grammatical morphemes in English for a Japanese child. Hakuta is not able to conclude whether this is a result of differing methods of data collection or scoring or whether the child in the Japanese study was 'unusual', but Larsen Freeman (1975) describes a similarity between the acquisition sequence reported by Hakuta and that of a small group of

Japanese adults in her own study[2]. From her study of adult Spanish speakers in formal, naturalistic and mixed environments, Pica (1985) finds that

> classroom instruction appears to accelerate the acquisition of the linguistically simple *-s*, retard the acquisition of the more complex progressive *-ing*, but have no effect on the developmental course for the highly complex article *a*
>
> Pica (1985: 149)

Thus the evidence so far is not conclusive. There are also suggestions that other issues, such as linguistic context, may sometimes (for at least some learners), affect the frequency of application of a rule (Abraham, 1984; Dickerson, 1975; Ellis, 1988), or, for example, the frequency of morphemes in normal speech may influence their order of acquisition (Larsen-Freeman, 1976).

Pienemann (1985) summarises and criticises some of the arguments for and against formal instruction in language learning, and the question of whether it is considered useful to tailor instruction of linguistic forms according to learners' developmental levels. (See also Ellis, 1990.) Although this is an important debate, the relevant question in relation to Mr. Collins is whether a likely acquisition sequence can be identified for the particular aspect of the domain, in a manner which is compatible with the language tasks in the system, and, if so, whether this can be implemented in a useful way. (Clearly 'a useful way' still needs to be defined.) Similarly, although important, the issue of the methodology used in the various studies undertaken previously (see e.g. Burt & Dulay, 1980) is not our main concern here. It is the *notion* of acquisition order which is the starting point rather than the results of any particular studies. We are not here looking at acquisition orders as a means to determine instructional actions as has been the main focus in the past; this is not the goal of the research to be presented here. The question is whether acquisition sequences can be used to aid system *diagnosis* as an additional source of information for *student modelling*. For example, if a learner is at stage X, and is exhibiting probable overgeneralisation of a rule for pronoun placement, for the particular rule being attempted he is far more likely to be overgeneralising a rule from stages X - 1 (or below), than from X + 1 (or above), as, in theory, he should

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2 There is the related question of whether L_1 and L_2 acquisition sequences are identical. Clahsen (1988) discusses differing acquisition of German syntax by native German children and adult learners of L_2 German. The acquisition sequence described by Dulay and Burt (1973) did not coincide with that found for L_1 speakers, such as described in Brown (1973). However, see Milon (1974) for a case study of a 7 year old's development of negation (in Hawaiian Creole), which does appear similar to L_1 acquisition of negation.

not yet be in a position to process sentences at stage X + 1. Thus, the various arguments for and against designing instructional syllabuses around an acquisition order are irrelevant in this case. The brief description presented above is provided simply to indicate where the relevant points for our case of student modelling find their source. As we are not dealing with actual instruction in this research, our arguments will differ.

2.3.2 Other Systems Concerned with Sequencing

A natural acquisition sequence for the target material is rarely considered in CALL. Even researchers who view language learning as a process which is in evolution do not necessarily represent this evolution in their system. See, for example, Schuster and Burckett-Picker (1996), who describe a model of the following six strategies of learning: translation; positive transfer; negative transfer; simplification; reduction of redundancy; overgeneralisation. Their student model focuses on the way people produce language in terms of these six issues, but does not take into account the notion of acquisition sequence (despite asking the question of what variables may influence the learning process).

There are a few exceptions to this lack of reference to stages of learning. Zähner (1992) states 'only if we can explain why a certain structure appears at a particular stage in the language learning process . . . can we claim to provide a true explanation'. Chanier et al (1990) describe an *applicable rule* as 'a rule that it is reasonable for a student to have at a particular stage of learning'. When defining applicable rules in their system, an expert may enter into the 'comments slot' relevant information, an example of which may be the stage of learning at which the occurrence of that error is most probable (Chanier et al, 1992). Similarly, Chanier & Renié (1993) state that 'a computing system needs to know what are the different steps every learner traverses during her/his apprenticeship'. The authors aim to obtain results on acquisition stages of French interrogatives for learners of French as a foreign language, to compare to the stages of acquisition of this aspect of the language as the native tongue.

This question of acquisition sequence tends also to be avoided in ILEs for other domains, though again, there are a few exceptions. For example, in discussing multiple levels of domain representation in physics, Ploetzner et al

(1990) state that qualitative and quantitative reasoning must both be accounted for when considering the various knowledge structures and different ways of reasoning which may be found as a learner gradually comes closer to being an expert. They describe a framework which allows an individual to interact with the system at the level which suits best. In modelling the acquisition of quantitative physical knowledge the authors state that a cognitive model of a learner should progress through a sequence of mental domain representations which remain compatible with those traversed previously, and such a model should also account for transitions between different levels. Ploetzner et al liken this sequencing to that of White and Frederiksen.

White and Frederiksen (1986; 1987) argue in the context of an ILE for electrical circuits, for model evolution; a progression of upwardly compatible models. Students should transform their own models to follow this progression. White and Frederiksen's modelling is expert-based, as they claim that through the design of appropriate model progressions and associated problems, incorrect model transformations will be improbable.

Sime's (1994; 1995) approach to sequencing differs from the above; she describes MS-PRODS, a system based on multiple qualitative and quantitative models of a physical system. Sime discusses model progressions more in terms of model meanderings (1995), as a network of models is used where there is some overlap between models, rather than a strict linear sequence of models.

A final example of a system concerned with sequence is Integration-Kid, a system for indefinite integration (Chan, 1991). In Integration-Kid, students will realise the inevitability of performing below perfection; that this is a normal manifestation in the process of learning. Integration-Kid is a learning companion system (LCS), where knowledge of the computer learner and human learner, in many cases with non-identical beliefs and misconceptions, evolves towards expert knowledge, thereby also becoming closer to the knowledge of each other. However, despite recognition of learning as a process, the approach of the LCS claims to reduce the centrality of, or even the need for a student model, as learning is viewed in a more social context. There is therefore no explicit modelling of these learning stages.

Returning now to language, COALA (Pienemann, 1992) is a computational system to help analyse learners' interlanguage. COALA is semi-automatic, thus easing the task of analysis for the researcher, while allowing him some control over the analysis. Manual analysis occurs also for aspects of interlanguage which are difficult to recognise automatically. COALA is therefore a tool for interlanguage analysis rather than teaching, but because it must be able to deal with various interlanguages (currently different levels of L_2 English, French, German, Italian and Spanish), it must be able to describe different stages of acquisition, and is therefore relevant to student modelling in CALL. However, as it is partially manual it is not suited to direct importation into the usual type of CALL program, though, as will be seen in section 4.5, this does not mean that some aspects of a 'COALA-like' system could not be useful to *learners themselves* (in addition to researchers into language learning).

2.3.3 Implications for Mr. Collins

Although there is still much discussion about the nature of interlanguage, and also about instruction in language learning, it is nevertheless clear that it would be useful to represent the learner's *developing interlanguage* in student modelling, not only because the various states of the interlanguage can be used to help represent learner beliefs at different stages of learning, but also because, as there are some developmental features typical across learners in general, this information can be used to help check that the diagnosis of the system is the most likely alternative. This could apply to a variety of student modelling approaches; for example, in a malrule approach rules can be ordered such that those most likely to apply at a particular stage in learning are consulted first when the learner is *at that stage*. Similarly, in a more complicated dynamic modelling approach, heuristics can be defined to indicate a search sequence which is most likely to be applicable at any particular time. Note that we are not claiming that there is a typical sequence of evolution of *errors*[3]. However, the fact that there is a degree of natural sequencing for the *acquisition of rules* is likely to have some influence on errors to be expected, if these are found to occur in some environments more than others.

An empirical study can be used to investigate developmental issues. In the context of Mr. Collins this requires experimentation to ascertain whether a predictable

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3 A sequence of errors was not found in the data obtained from study 1.

acquisition order can be determined for the limited domain of the rules of pronoun placement in European Portuguese, which would at least be appropriate for the target users of the system.

Sequencing based on developmental orders has not been considered to a large extent in CALL, despite a history of discussion of this subject in the applied linguistics literature. There are no language systems whose implementation of such a sequence could be usefully applied in student modelling; therefore it is useful to look to other domains to ascertain whether their approaches may be suitable. In physics we saw some examples; Sime's (1994; 1995) network of models is less relevant here as we are not dealing with instructional sequences, but rather sequence as a possible predictor of likely difficulties at a particular point in the learning process. This is a different issue. White and Frederiksen's (1986; 1987) sequence of domain models is also inappropriate here, as the sequence is based only on correct knowledge. However, language learning is unlikely to occur without error; indeed, this is *normal* - a natural part of the language learning process.

Therefore, what is required is a student model that can represent interlanguage development; a sequence of models which are to a certain extent upwardly compatible to allow for the acquisition of rules, but where errors are also allowed for, and even expected, and which can be seen as a sign of progression (i.e. errors are not necessarily failure). The student model, as well as representing interlanguage evolution, should also be able to use its knowledge of the regularities in acquistion to help diagnosis. For example, it should know that later stages of interlanguage are less likely to be used in overgeneralisation than stages earlier than that at which the learner currently finds himself. Interlanguage development does not necessarily correspond to sequences of presentation or instruction, therefore results of the empirical study required should be used to determine a *student model continuum*.

2.4 Learning Strategies

This section describes research on the learning strategies used by foreign language students, concluding with implications for the design of Mr. Collins. Whilst there is a lot of work on learning strategies in general, we will here focus on

research specific to language learning strategies as there is an increasing amount of literature concentrating on the language domain[4]. O'Malley et al (1985b) suggest that there may be no learning strategies related *only* to language learning, but that there could be a subset of more general strategies which are especially useful in the development of students' skills in a foreign language. This is true even for strategies that intuitively appear specific to language: although Cook (1993) states that translation is an exception to the generality of strategies, O'Malley et al (1985b) describe the similarity of translation in language to translation of narrative descriptions of mathematical problems into numeric form, and Bull et al (1995) suggest a similar strategy in learning about electrical circuits.

2.4.1 Language Learners' Use of Learning Strategies

An important part of learning involves the use of learning strategies. This has been shown to be equally true for the learning of foreign languages as with other subjects. Fox and Matthews (1991) describe learning strategies as being 'concerned with how learners use their brains consciously and purposefully to handle their learning and make it more effective'. It appears that the same type of strategies are employed by the language learner as by learners of other subjects, and these strategies apply to both instructed and uninstructed language learning (O'Malley and Chamot, 1990). Abraham and Vann propose that

> learners have, at some level of consciousness, a philosophy of how language is learned. This philosophy guides the approach they take in language learning situations, which in turn is manifested in observable (and unobservable) strategies used in learning and communication. These factors . . . directly influence the degree of success learners achieve.
>
> (Abraham & Vann, 1987:96)

Wenden (1987) distinguishes three groups of learners: those who believe in using the language, those who wish to learn about the language, and those who consider personal factors such as emotions or aptitude to be important. The types of strategy used can be determined by the particular set of beliefs held by a student. Horwitz (1987) presents BALLI (Beliefs About Language Learning Inventory) to identify learner beliefs, and to try to answer questions such as the links between beliefs about language learning and strategy selection, and variables affecting beliefs.

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4 For an overview see McDonough (1995).

Based on his study of seven exceptional language learners, Stevick (1989) also concludes that students differ in the manner in which they approach language learning, and locates learners generally as falling within an overall pattern focussing on verbal and non-verbal imagery. He describes each of his learners as having a distinct technique, classifying them thus: 1. intuitive learner; 2. formal learner; 3. informal learner; 4. imaginative learner; 5. active learner; 6. deliberate learner; 7. self-aware learner. Due to these variations in approach and beliefs about learning a language, it seems fair to assume that different learners will adopt different strategies, some possibly more successful than others. For example, Rubin (1987) observes that in general, learners who rely too heavily on a strategy of literal translation enjoy very little success. Ellis (1992) distinguishes learners who strive to develop their knowledge of linguistic rules, and learners who focus on communication with less attention to grammatical correctness (studial versus experiential learners). Ellis concludes that learners are likely to progress differently depending on their chosen approach; moreover, in his data, acquisition of linguistic rules and fluency are inversely related. Of course some learners may have an approach which is more balanced, and such learners may achieve greater success overall.

Using the term 'personal competence', Stevick (1982) states that students need *techniques* which can be used with new material. Techniques are defined as things a student knows how to do. It is not only the techniques themselves which should be learned, but also timing for techniques (e.g. how long flash cards should be used, and the appropriate time intervals between their use). Once various techniques are known it should become possible for individuals to identify what is most effective for them. Following this stage it should be possible to develop an awareness of how to adopt a new technique or modify an existing one (and an awareness of the individual's reactions to different techniques, and ways to deal with these reactions). This description of what constitutes, and should be developed to achieve personal competence was published in 1982, before the 'topic of language learning strategies' became so popular. Much of the literature dates from later[5], but the relationship between Stevick's statements, and descriptions in this literature, are clear.

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[5] Rubin (e.g. 1975; with Thompson, 1982) was working on 'good' language learners at the time.

Oxford (1990) states that more aware learners who are further advanced in their study tend to use better strategies. Similarly, O'Malley and Chamot (1990) claim that the most effective learners have a larger repertoire of strategies, and use strategies more effectively than less efficient learners. Skehan (1989) warns for caution and the need for longitudinal research to determine whether broader strategy use facilitates learning, or whether it is proficiency which allows broader strategy use. Oxford (1993) summarises the following, additional variables on learning strategy selection: motivation, gender, cultural background, type of task, learning style, age and stage of L_2 acquisition.

Manning (1991b) observed a variety of strategies employed to assist in the learning of French vocabulary, for example: concentration, mouthing and spelling - in both cases either silently or audibly, writing with or without meaning and determiners, self-testing and monitoring, and individual cases of mnemonic rules and imagery. In a short multiple choice homework exercise, the following strategies were found to be widely used by students in one of the empirical studies reported in this thesis (study 5, see section 4.4.6): resourcing, studying material before attempting the exercise, pure guessing, checking while working and also after completion of the task. Rivers (1983) identified a range of strategies in her own learning of Spanish, and was acutely aware of areas in which she lacked competence.

It is possible for a single learner to approach the learning of different languages in different ways; for example Stevick (1989) describes one student whose approach to the learning of Finnish grammar contrasted with his previous (also successful) attempts at learning German and Russian. The present author's experiences relating to tolerance of errors and risk-taking reveal two distinct approaches depending on whether or not the language in question had been formally taught. Contrasting techniques can also be applied within the same language; Stevick cites a learner who combines a formal with an informal approach, although these two aspects were not equally balanced. It should also be remembered that not all learners are able to manage both techniques.

Holmes and Ramos (1991) identify the existence of negative strategies such as 'copying' and 'classroom coping'. Horwitz (1987) cites a learner who asked whether it was true that some learners do not actually translate from their first

language when speaking in a foreign language. On hearing that this was indeed the case, and moreover, more fluent speakers tend not to translate, this learner decided to think about his approach. It is clear that such learners could benefit from the simple knowledge that not everyone shares the same beliefs about learning a language.

It would appear from these studies that those students who use appropriate learning strategies can achieve better results in their learning of a foreign language. Moreover, it is those learners who use a greater variety of strategies that tend to be the most successful. Rubin (1975) therefore proposes that poorer learners should be taught the strategies employed by good learners. However, Vann and Abraham (1990) present contradictory evidence to the claim that poorer learners use less learning strategies. Indeed, it seems that some unsuccessful learners use many of the same strategies as those students who are more successful. In such cases the focus should be more on the facilitation of strategies *appropriate* to the task. Wenden (1991b) also calls for training in learning strategies to take account of the tasks which the learners involved are required to carry out.

Kohonen (1992) maintains that reflection on learning leads to an increase in awareness, which in turn aids the development of autonomous learning. Kohonen states:

> Strategies. . . can become automatized and function without conscious control. But they can also be brought to conscious observation and awareness and can be modified as a result of conscious effort.
>
> (Kohonen, 1992:24)

Several researchers (e.g. Awang Hashim & Syed Sahil, 1994; O'Malley & Chamot, 1990; Sharkey, 1994-95) claim the need to provide more information about, or teach language learning strategies directly. Holmes and Ramos (1991) state that

> in order to help learners assume greater control over their own learning it is important to help them to become aware of and identify the strategies that they already use or could potentially use.
>
> (Holmes & Ramos, 1991:198)

Oxford (1990) and Wenden (1991a) provide information for teachers for promoting learners' language learning strategies. Rubin and Thompson (1982) offer accessible guidelines for the learner to follow. Oxford (1993) states that the most successful

attempts at strategy training have been explicit, rather than implicit. Wenden (1986) also concludes that learners should be advised of the advantages of using the strategies in which they are being trained, and induced to *experience* the benefits. Cohen (1991) argues for the encouragement of awareness of the learning process, thereby increasing learner awareness of what works *for them*.

This section has shown that there is now quite extensive literature on the use of learning strategies in foreign language learning, most of which assumes that actual strategies used by students may affect their learning outcomes. Several researchers also claim the benefits of strategy training. Regardless of whether one adopts the view that all learners should be taught a (certain) range of strategies - which, in fact, we do not: we prefer the approach of helping learners become aware of a wider range of possible strategies, and to identify what works best for them as individuals - it will at least be useful to enhance the awareness of learners of the variety of approaches available. We now look in more detail at one particular learning strategy classification.

2.4.2 O'Malley and Chamot's Classification

This section describes the work of O'Malley and Chamot on learning strategies identified, and the resulting language learning strategy classification and strategy training programme (O'Malley & Chamot, 1990).

The learning strategies in figure 2.1 were observed amongst language students:

metacognitive strategies	cognitive strategies	social strategies
planning	repetition	question for clarification
directed attention	resourcing	cooperation
selective attention	grouping	self-talk
self-management	note taking	self-reinforcement
self-monitoring	deduction/induction	
problem identification	substitution	
self-evaluation	elaboration	
	summarization	
	translation	
	transfer	
	inferencing	

Figure 2.1: language learning strategies identified by O'Malley and Chamot

A summary of O'Malley and Chamot's definitions of these strategies will be provided here, for clarification (summarised from O'Malley and Chamot, 1990:137-139).

Metacognitive strategies

Planning: previewing (advance organization); proposing strategies; generating a plan (organizational planning).
Directed attention: advance decision to attend to the task without distraction, and maintaining attention.
Selective attention: advance decision to attend to specific aspects of the language or situation which facilitate learning.
Self-management: understanding factors which aid the task, and arranging for those factors to be available; maximisation of what is already known.
Self-monitoring: checking, verifying or correcting while carrying out the task (comprehension, production, auditory, visual, style, strategy, plan, double check).

Problem identification: identification of what needs to be solved, or of a feature of the task which impedes task completion.
Self-evaluation: checking after task completion (production, performance, ability, strategy, language repertoire).

Cognitive strategies

Repetition: repeating words or phrases.
Resourcing: using reference sources.
Grouping: ordering, classification or labelling according to common characteristics, and recall of information through previous grouping.
Note taking: noting key words and concepts in some form.
Deduction/induction: conscious application of rules (rules learned from teachers, textbooks, etc., or rules developed by the student himself).
Substitution: selection of alternatives (approaches, plans, words/phrases).
Elaboration: relating new information to prior knowledge, or to other aspects of new knowledge; making personal associations (personal, world, academic, between parts, questioning, self evaluative, creative, imagery).
Summarization: summarising language and information (mental or written).
Translation: more or less word-for-word translation.
Transfer: use of prior language knowledge.
Inferencing: guessing or predicting based on available information.

Social strategies

Questioning for clarification: requesting explanation, verification, rephrasing, examples (about material); requesting clarification or verification (about task); asking self.
Cooperation: working with peers on various aspects of the task.
Self-talk: anxiety reduction through employment of mental techniques.
Self-reinforcement: arranging rewards on successful task completion.

O'Malley and Chamot (1990) describe CALLA: Cognitive Academic Language Learning Approach, which is a programme of instruction based on cognitive theory, for students of limited English proficiency (LEP) who will be taking part in mainstream academic education. CALLA has three components, one

of which is direct instruction on learning strategies. (The other two components are 'content-based curriculum' and 'academic language development'.)

From those language learning strategies identified by O'Malley and Chamot (as full strategies or one of several aspects of a particular strategy), the following are taught in CALLA:

Metacognitive Strategies:

advance organization, advance preparation, organizational planning, selective attention, self-evaluation, self-management, self-monitoring.

Cognitive Strategies:

auditory representation, deduction, elaboration, grouping, imagery, inferencing, note taking, resourcing, summarizing, transfer.

Social Strategies:

cooperation, questioning for clarification, self-talk.

These strategies are considered by the authors to be particularly useful for LEP students who are needing to learn content (e.g. science and mathematics) as well as language, and these strategies appear also to match those used by the most effective language learners. CALLA is designed for upper elementary and secondary students who are considered 'intermediate' or 'advanced' in English as a second language.

The benefits of using such strategies in combination can be illustrated by the following extract from O'Malley et al (1985b):

> One of the ways to enhance note-taking skills with a metacognitive strategy would be to provide students with specific types of information to attend to in lectures, that is, to use *selective attention* for specific linguistic markers. Linguistic markers that are often used for emphasis in a lecture or that reflect the organization of the lecture are appropriate for this purpose, for example, *first, the most important point is...*, and *in conclusion*. Note-taking skills could possibly be enhanced even further by encouraging students to *cooperate* in identifying omissions or errors in their notes or in interpreting information worth remembering from the lecture.
>
> (O'Malley et al, 1985b:569)

2.4.3 Other Systems Concerned with Learning Strategies

Although the general second language acquisition literature shows a recent interest in the issue of learning strategies in foreign language learning, there have been few attempts to incorporate an understanding of different approaches to learning into the CALL environment. The main difficulty is that traditionally CALL programs are very limited in their ability to adapt to the individual, tending either to offer fixed, inflexible routes through material, or hypertext programs which allow the user far greater freedom in navigation, but no guidance as to the route or method which may be most suitable for their own learning, and certainly no facilitation of appropriate learning strategies. Multimedia tends also to be similarly limited, and even programs using artificial intelligence techniques do not usually include an understanding of learning strategies.

However, one system which has looked at this issue is that of Fleissner et al (1991), who constructed a system to test the hypothesis that 'slow learners will benefit from a language learning program that explicitly gives the opportunity to acquire strategic thinking'. Comprehensive feedback is provided 'to guide the learner to develop a metacognitive concept in regard to her language activities'. They proposed that a language learning program should both allow acquisition of the language structure and promote learner control over the particular strategies used. However, this learner control appears to be limited to easing navigation, help on the specific problem and the selection of various resourcing options.

An ICALL system currently being designed is taking a broader view of learning strategies. As in Mr. Collins, Maritxalar and Díaz de Ilarraza (1994) are also basing their system's treatment of learning strategies on the classification described by O'Malley and Chamot (1990). This aspect of their work has not yet been precisely defined; it will be interesting to see how the two systems compare once their implementation is further underway. The fact that the issue of learning strategies is being comprehensively investigated by these authors is likely to lead to a more thorough system than that of Fleissner et al.

A different approach is taken by Gillespie and Gray (1992), in MetaText. MetaText encourages students to note new information relevant to their translation process, and also to consult information recorded by themselves on previous

occasions, to help in the completion of the current translation task. Although MetaText is not an 'intelligent' system: it is not able to judge a student's success in his note taking, or resourcing of previously recorded information (and has no way of understanding the domain, the student or teaching), the simple fact that it reinforces learners' resourcing, categorisation and note taking skills is likely to make students more autonomous, and therefore more successful language learners.

Another system aimed at promoting learner autonomy is proposed by Moulden (1986/87), who describes the specification of a counselling system (which could also be used in browsing or consultation mode, or provide exercises), for 'self-directed' learners. Twelve aspects of the proposed program are summarised; those most relevant here include the 'language learning resources file/locator' and the 'learning project progress check up'. The 'language learning resources file/locator' provides information on all the available resources, and the function of the 'learning project progress check up' is to

> help learner to assess progress, to diagnose causes of unsatisfactory progress and to find better ways of working. Help learner to acquire habit and means of monitoring progress and adjusting process alone.
>
> (Moulden, 1986/87:106)

Although not encouraging students to explore the use of learning strategies, *ArtCheck* (Sentance, 1993) uses the distinction between experiential and studial approaches to learning (described in Ellis, 1992) in order to better tailor its explanations to the individual. Thus, in system explanations, learners preferring the experiential approach receive example sentences instead of rules, or where both are used, examples are presented first. The reverse occurs for studial learners. This use of learning strategies differs from those described above in that it is not the two strategies which are taught, nor are students encouraged to become aware of various strategies, but rather, this distinction is used to individualise explanation to suit the learner's own (stated) style.

Another ICALL system which includes a distinction between a semantic (communicative) and grammar-based approach is LICE (Bowerman, 1990). In the grammar-based approach tutoring occurs at the time a problem occurs, whereas with the communicative approach all tutoring takes place at the end of the session. A main difference between *ArtCheck* and LICE is that in *ArtCheck* students choose the type of explanations received, according to their own learning preferences. In LICE

the teaching approach is based on the student's level (intermediate or advanced), and does not take account of his own learning strategies or style[6]. However, Bowerman does state that information about students' learning strategies and learning styles should be included in a student model; it is therefore assumed that if LICE were to be developed further, this issue of preferred approach would be linked into the selection procedure for LICE's teaching actions.

Another program which considers learning strategies, but from a rather different perspective, is *Cognate?* (see Musson & Bull, in prep). This system has been implemented initially to research different presentations (colour, font size, position on screen) for (in this case) the learning of vocabulary. Three types of word pairs are presented: cognates, near cognates and false cognates, and students are made aware of the different forms of presentation as an aid to their learning of the separate groups. For example, if a student remembers that a certain word pair is red and in the bottom left hand corner, he will know that these are false cognates, and he should exercise caution. The aim is to eventually be able to configure systems to use those presentation strategies which are most effective in general, or for an individual, and where appropriate to also encourage students to adopt these strategies for their own use in their learning (having as an example the system's method(s) of presentation).

It has been seen that language learning strategies are an important consideration in second language acquisition. Some systems which include a 'knowledge' of such strategies were described, and even though these tend often to have a more restricted view of learning strategies, most benefit from their understanding of the strategies included. Thus even a limited understanding of learning strategies can benefit a CALL program. In the following section we look at the implications for our system, arguing that a more comprehensive treatment of learning strategies can be used to encourage more reflective learning[7].

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6 Note that Stern (1992) states that from the theoretical perspective it is possible to argue for both directions, i.e. for either teaching approach to precede the other.

7 Reflective not as 'bouncing back what the teacher throws' in the sense of reflective versus productive performance (as described in Stevick, 1976), but in the sense of reflecting on, or thinking about learning.

2.4.4 Implications for Mr. Collins

It is useful to incorporate a treatment of language learning strategies into an ICALL system. However, consideration should be given to which strategies should be promoted, and even which should be dealt with at all. As the classification of O'Malley and Chamot (1990) is extensive, this is a very useful starting point. However the two situations are different: CALLA is not computer based, whereas Mr. Collins is. Mr. Collins is (currently) designed for older (university level) students who are beginners in their foreign language, and who are not also trying to learn any specific content area in this language. Therefore this is not an attempt to implement CALLA on a computer, but to use those strategies from CALLA which are relevant, and others identified by O'Malley and Chamot which are not taught in CALLA, but which students have been observed to use. Figure 2.2 shows which of the learning strategies identified by O'Malley and Chamot were considered appropriate for treatment in the ICALL environment, and therefore included in Mr. Collins. Many of the strategies taught in CALLA can be usefully handled in ICALL, and many of those not taught in CALLA are also not represented in Mr. Collins. Here, those strategies which are either taught in CALLA but not represented in Mr. Collins, or those which are not taught in CALLA but are treated in Mr. Collins, will be the focus of the discussion.

	LEARNING STRATEGIES TAUGHT IN CALLA	
	in Mr. Collins	not in Mr. Collins
metacognitive:	self-evaluation self-monitoring (organizational planning of strategies)	advance organization advance preparation organizational planning selective attention self-management
cognitive:	deduction grouping inferencing note taking resourcing summarizing transfer	auditory representation elaboration imagery
social:	cooperation question for clarification	self-talk

Figure 2.2: comparison between strategies in CALLA and in Mr. Collins

Learning strategies taught in CALLA, but not handled in Mr Collins

Advance organization involves previewing concepts and key ideas in material to be studied. This, although clearly useful, is less appropriate for Mr. Collins, as students are not using the system in preparation for an approaching class; the language exercises in the system are (at the moment) the final point of practice. In addition, the target domain is currently very restricted.

Advance preparation is concerned with rehearsal of language in order to handle a task. Again, this is less appropriate for Mr. Collins, as any such preparation would have occurred before a student's use of the system (as this is *advance* preparation).

Organizational planning (apart from of learning strategies, which *is* handled in Mr. Collins), is concerned with planning sequencing, parts and key ideas. Again this is useful, but the domain of Mr. Collins is currently too restricted to enable this strategy to be implemented to good effect. (This would be a good strategy to include in a future, broader version of the system.)

Selective attention is not yet implemented. It would be interesting to see which aspects of the interaction were deselected by which students in their selective attention, however the current aim of the system is to discover the extent to which the various aspects of the system can be promoted. Once this is established it will become feasible to research whether some students have more succes when using only certain parts of the system, and what type of students work well in which areas of the environment.

Self-management is not so appropriate for consideration in this ICALL system, beyond consideration of the amount of time spent using it, and selection of what to do in the system. As stated above, the current possibilities are still relatively restricted. However, this could be considered in the future.

Auditory representation is not appropriate in ICALL, as a system cannot access the personal, internal auditory representation the learner effects.

Elaboration is also very personal; the system cannot share all the other knowledge of a student, or guess at personal associations learners may make.

Imagery also works best if it is personal, so although students could potentially be encouraged to express their images, the system could not interpret such 'free' drawings. Indeed, there is no reason why a learner should use his time in externalising his images if imagery is working well and faster when remaining internal to the student. (Pre-stored images could be offered, which the system would be able to reason about, however this would only be worthwhile if these proved to be more effective than students' own images. This is probably unlikely at least for those learners with a more graphical orientation.)

Self-talk is also very difficult as it involves mental techniques which are not accessible to the system.

Learning strategies handled in Mr. Collins, but not taught in CALLA

There are two further learning strategies which are treated in Mr. Collins but not taught in CALLA:

Substitution is used by students, so the system must be able to identify that this occurs in order to suggest alternatives at appropriate times. (Substitution can, in fact, be useful if the student is experiencing persistent difficulty.)

Translation is also used by students, thus although direct translation can be negative, and Mr. Collins will try to guide students away from this, it must be able to trace the use of this strategy in order to know that it has occurred.

It can be seen that some learning strategies which are taught in CALLA are not handled directly in the ICALL system in which Mr. Collins is embedded because this is not an appropriate environment. Other strategies were not included at this stage because this is still an early investigation, and the system is necessarily limited. Such strategies should be considered in the future. Two more, negative strategies, which are not taught in CALLA are included in Mr. Collins. This is simply because some students use these strategies, and ICALL is a reasonable place to encourage alternatives.

Thus, the following language learning strategies are recommended for treatment in Mr. Collins:

Metacognitive Strategies:

organizational planning (of strategies), self-monitoring (production/visual/strategy/double checking), self-evaluation (performance/ability/strategy use).

Cognitive Strategies:

resourcing, note taking, grouping, summarization, deduction, substitution, translation, transfer, inferencing.

Social Strategies:

cooperation, question for clarification.

This is a more comprehensive treatment of learning strategies than in most of the other systems described in section 2.4.3. Details of how these strategies are implemented is given is section 4.4.

It is, of course, not sufficient to simply implement these learning strategies in an ICALL system without consideration of how the system should introduce them, or the order in which they should be introduced to students. This should depend on the student's instincts and preferences (as he has a valid point of view regarding the types of learning strategy he should use!), and also on some mechanism to guide the system's introduction of strategies if the student expresses no preference. This mechanism should take account of how likely a learner is to understand the use of the different strategies (which is likely to be influenced by those strategies already used).

We also saw in section 2.4.1 that learners' beliefs about how to learn a language may affect their strategy choice. It may therefore be useful to make learners aware that people have different beliefs (and that there may therefore be different ways of learning), as well as increasing their awareness of different learning strategies. However, there should be no assumption that particular strategies will necessarily be more useful than others for (particular) students.

In this section research on language learning strategies was presented in order to justify the design of the learning strategy component of Mr Collins. In the next section we look at research on language awareness.

2.5 Language Awareness

In this section language awareness is described in relation to second language acquisition, the domain of this thesis. The view presented will be confined to awareness of language form and different approaches to language learning[8], with the aim of encouraging learners to reflect more on their learning.

2.5.1 Language Form

Kohonen (1992) states:

> It is helpful for language learners to know the 'terrain' of the second or foreign language: what elements there are, how they are inter-connected and patterned, what combinations are possible and likely to occur, which ones occur frequently, and what similarities and differences exist between their native languages and the target language. Such information will create order out of the seemingly chaotic primary data.
>
> Kohonen (1992: 25-26).

There has long been discussion about the relative merits of explicit versus implicit approaches to language learning, with trends frequently changing. Although there is disagreement about the extent of its importance, there is, however, evidence that greater awareness of language form can be facilitative of language learning. Schmidt (1990) hypothesises that 'intake is that part of the input that the learner notices'. Rutherford and Sharwood Smith (1985) describe 'consciousness-raising'

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8 The term language awareness is also applicable outside these areas, for example in language awareness across the curriculum (e.g. Anderson, 1992), or directed towards teacher education (Brumfit, 1992), or a view of language awareness aimed at the more general reader, as can be found in van Lier (1995). Tinkel (1991) discusses a language awareness course in secondary schools (for English as L_1). Clark and Ivanic (1991) describe an approach to consciousness-raising about the writing process for university students writing in English (as their native, or a foreign language), and Scott (1991) discusses language awareness in reading. Language awareness as applied to foreign language learning can also have different perspectives. For example, Critchley et al (in press) describe an approach to translation classes in university education where awareness of intra-lingual and inter-lingual differences in text styles is of importance. Salkie (1994) presents the wider approach which integrates language awareness across the whole degree course for the applied language degree (incorporating language learning and linguistics in a united manner).

as 'the deliberate attempt to draw the learner's attention specifically to the formal properties of the target language'. Fotos (1994) suggests using grammar consciousness-raising tasks to combine a communicative language approach with a more formal grammar instruction approach. Van Baalen (1983) finds that learners taught explicitly equal those experiencing an implicit approach in some structures, and outperform the implicit group with other structures. Yan-ping (1989) asserts that learning is facilitated by form-focused instruction, though again, explicit instruction is not better than implicit instruction for all structures. Both van Baalen and Yan-ping find (tentatively) that explicit instruction is more useful with simpler structures, but there is little difference between explicit and implicit approaches for more complex ones. In a consideration of the effect of explicit and negative data, Schwartz (1993) argues that only primary language data (instances and examples of the target language) can lead to *competence*, though *behaviour* may be influenced by explicit and negative data. VanPatten and Cadierno (1993) state 'instruction is apparently more beneficial when it is directed at how learners perceive process input rather than when it is focused on practice via output.'

Ellis (1992) concludes that although practice may have some value, what is more important is the development of explicit knowledge. He states that consciousness-raising leads indirectly to the acquisition of implicit knowledge, i.e. it has a delayed effect. This takes place firstly by facilitating the student's general awareness of, and comparison of features which will enable integration to take place, and secondly the explicit knowledge gained will be available for when the student is ready to process it. Terrell (1991) proposes three ways in which explicit grammar instruction may influence acquisition. Firstly, it can provide an 'advance organizer' in order that learners will have available information about forms and structures which will help in the processing of subsequent input. One example given is:

> In German there are six words which correspond to the meaning of the English word 'the': der, die, das, den, dem, des. For example, the following sentence reveals three different words for 'the': Das Kind gibt dem Mann den Bleistift. (The child gives the man the pencil.) There are reasons for the choice of one or the other, and you will begin to learn them shortly. For now, remember that all six German words correspond approximately to the meaning of English 'the'.
>
> Terrell (1991: 59)

The second influence of explicit instruction in grammar is that it provides a meaning-form focuser for complex morphology; i.e. non-salient, redundant

relationships could be made more salient. One way to achieve this in grammar-focused tasks is to provide many examples of a single meaning-form association in meaningful input. An example includes the following description of what the teacher does on Sundays. Such a narrative, in extended form, can be used to indicate a particular grammatical point; in the example below the first person singular verb form in the present tense. All verbs end in *o* (*levanto, desayuno, hablo, salgo*).

> **Los domingos me levanto más tarde, a veces a las diez, y a veces a las once. Luego, desayuno cereal. Casi siempre hablo por teléfono a mi hermano, Pablo. En la tarde salgo con algún amigo a pasear.**
>
> **Terrell (1991: 59)**

The final description given by Terrell for the influence of explicit grammatical instruction is that the provision of forms for monitoring may in itself lead to acquisition, if it can be assumed that learners' own output is available as input to their acquisition.

We will not here go into the question of which students will find explicit instruction of grammatical rules the most helpful. As seen in section 2.3, the learner's current stage in the acquisition sequence may also be a variable affecting the usefulness of instruction of a particular form. Here we are assuming that, in general, there will be at least some students who prefer an explicit approach, and it is these learners at which the system is primarily aimed. Furthermore, our system is not researching *instruction*, but rather, student modelling. Frankenberg-Garcia et al (1994) state that learners of Portuguese tend already to have a high level of linguistic awareness, as Portuguese is rarely their first foreign language. In addition, the majority will be learning Portuguese out of interest for the language, rather than a practical need to know it.

2.5.2 Other Systems Concerned with Awareness and Reflection

In the previous sections of this chapter the 'other systems' descriptions have been mainly directly related to the topic in question, e.g. systems concerned with language transfer, etc. However, for language awareness this is less easy; systems tend not to have the promotion of awareness as a primary goal. Thus we will move backwards one step, and take as the starting point a brief presentation of some systems which incorporate the idea of the provision of explicit rules. The purpose

is simply to illustrate that there are a number of language systems which provide the learner with grammar rules, and therefore it should not be too great a step to move on to fostering awareness of grammatical form. Subsequently a few systems which do consider the issue of language awareness are described. (In chapter 3 other systems designed to encourage reflection will be discussed, though these are not specific to language learning.)

Of the CAGE system, Swann states:

> Where language structure is clearly based on formal rules of manipulation this fact is emphasised in the exercises; no attempt is made to sugar the morphosyntax by hiding it in a meaningful context.
>
> Swann (1986: 5.14)

In many systems which involve the learner in considering explicit rules, the correction offered after erroneous input is immediate (e.g. Catt & Hirst, 1990; Weischedel et al, 1978; Schuster, 1986; Schuster & Finin, 1986; Imlah & du Boulay, 1985). In ET (Fum et al, 1988), over a series of sentences the system hypothesises the learner's misconceptions. When it is sure it offers its diagnosis to the student and provides correction. Although these systems may be useful in terms of their aims, the fact that immediate correction is provided restricts the opportunity to promote awareness and reflection in language learners.

Other systems which use explicit grammar rules in their interactions with students include the Fawlty Article Tutor (Kurup et al, 1992), where the student is *required* to identify a rule, and XTRA-TE (Chen & Kurtz, 1989), which has three different correction strategies (no-hint, indirect and direct correction). The strategy selected depends on the student's familiarity with the material. A more elaborate strategy is found in the intelligent language tutoring system of Schwind (1990), where the explanation strategy has five stages: simple indication of error; leading question; explanation of the error in grammatical terms; example; correction. (This is intended to *illustrate* how a tutoring session could run. Schwind states that this is not necessarily the only suitable teaching strategy.) In IEGRED (Jiang & Richards, 1993), the student is able to choose whether he identifies errors himself, with help from the system, or whether he receives an immediate diagnostic report from the system.

MARPLE (Teutsch & Vivet, 1993) takes a different approach. The main purpose of MARPLE lies in the evaluation of language learning. Where appropriate, feedback is given in terms of explicit rules. Feedback on evaluation is immediate, but this is given on paper in order that the student may take the information to his teacher for subsequent discussion.

Dickson (1995) states that CALL can be used to raise learner awareness by directing students' attention towards structures. Some systems have been planned and designed with this idea in mind: Schuster & Burkett-Picker (1995) argue that interaction with their proposed ITS will lead to the development of a learner's awareness of his interlanguage errors.[9] Schuster and Burckett-Picker (1996) claim that through system explanations of the reasons for errors learners will become more aware of problems, and so overcome them. Sussex et al (in press) state that if a learner wishes to access a particular word in their tools, he must type the root form. The intention is to direct students' attention towards the correct spelling, and to foster the skill of decomposition of complex words. In their prototype system based on conversation rebuilding, Aiello and Micarelli (1993) view the learner as a researcher who is generating and testing hypotheses. In rebuilding conversations from scratch, they are forced to think about the language. Similarly, Johns (1991) says, of data-driven learning of grammar:

> The pattern of learning shifts towards students finding things out for themselves about the target language including things which the teacher and or linguists are unaware of. In this context the role of the teacher becomes that of organiser of research rather than imparter of knowledge.
>
> Johns (1991: 22)

The notion of 'learner as researcher' is also strongly advocated by Wolff (1994), who argues for a role for computers in this activity.

An interesting idea is suggested by Claydon et al (1992): in their prototype the user can make comments about system suggestions. Although the system described does not actually analyse the comments, as would occur if the system were more sophisticated, this action could be a method of enhancing awareness. (However, Claydon et al do not discuss this possibility.)

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9 This is an unfortunate (though not uncommon) description, since interlanguage is by nature riddled with misconceptions. Errors in learner language as compared to the target structures is presumably what is intended.

Although not explicitly coaching or encouraging language awareness, BonAccord (Farrington, 1994) is a resource to offer instruction *about* the target language in addition to the learning *of* a target language (for L1 --> L2 translation). BonAccord may be used investigatively; while translating a sentence a student may at any stage request a list of possible next words. Farrington states that most students prefer to try their own translations, requesting suggestions when they become curious about alternatives, or stuck at a particular point. Through such consideration of alternatives there is potential to improve language awareness, for example, the selection of which (syntactically correct) version fits best.

Heuer (1991) argues for drill and practice in CALL. Although there is a place for such programs, Heuer claims that the main problem relevant to beginners is that they tend to translate word by word, and do not know how to express themselves properly in the target language. A major cause of difficulty for advanced learners is stated to be interference. Although this may be true, Heuer offers no evidence to support these claims for the learners concerned, and does not discuss possible alternative sources of difficulty. Indeed, even if this is true, it is not clear that drill and practice is necessarily the best solution; Heuer does not provide any detail on the type of programs intended. However, the author does state:

> we confront our students with exercises that are especially created for German native speakers and refer to Russian language means and constructions, which do not exist in German or differ from their German equivalents.
>
> Heuer (1991: 30).

Although Heuer does not discuss the possibility of enhancing awareness of language, this reference to differences between German and Russian could be used to encourage reflection on the issue.

An approach which is aimed specifically at developing learners' awareness of grammaticality[10] and differences between expression in two languages (English and French) is described by Richmond (1994). *French Assistant*[11] (version 4.0) is a program to facilitate English-French translation. However, as it relies more heavily on its dictionary than on rules, the translations are necessarily imperfect. Richmond claims that it is this feature which makes *French Assistant* 4.0 suitable

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10 Grammaticality concerns not just correct grammar, but also the appropriacy of structures used, in the context in which they are applied.

11 MicroTac Software (1990).

for the language learning context, for use by native English speakers learning French. Richmond asserts:

> Since *French Assistant* translates literally, one has only to give it a modified English text that sounds like French in order to make it produce correct French . . . This is, of course, the reverse of normal student behaviour, which so often consists of producing incorrect French that sounds like English.
>
> Richmond (1994: 71)

Two versions of the text are given to students: the source text (in English), and the French target text for which learners are aiming. The task is for learners to get French Assistant to translate the English source text into 'French', and then compare the French version obtained to the French target text. They then alter the *English* source and *French Assistant* retranslates, until the translation matches the target. The aim is that learners should become more aware of the differences that exist between the two languages. Because modifications to the English source can often result in 'odd' English, it is claimed that learners are more likely to notice and remember the structures necessary for use in French.

Chanier and Pengelly (1991) refer to the benefits of self reflection in their description of their *Interface for the Acquisition of Applicable Rules* (IFAAR) for student modelling in language learning. An applicable rule is a rule which applies in a particular situation. Chanier and Pengelly state with reference to the possibilities of the use of IFAAR for teaching:

> For a learner, the exercise of generating applicable rules from divergent sentences uttered by another learner can be a good way of imposing self reflection on his or her own system of rules. . . Although a learner will often be guessing the rules to explain what another learner has done, the task of generating an applicable rule will have coerced the learner into viewing and handling language from several viewpoints.
>
> Chanier & Pengelly (1991: 7)

2.5.3 Summary

We have seen in this section that there are benefits to promoting awareness of language form. It has also been shown that CALL programs dealing explicitly with grammar exist. Moreover, there have been a few suggestions that CALL can be useful in enhancing awareness of language form.

Previous sections of this chapter have concluded with implications for Mr. Collins. We reserve such discussion on this occasion until after presentation of

issues concerning collaboration and negotiation, anticipating at this point that these will be closely related to the approach to encouraging language awareness which is adopted.

At the start of this section it was also stated that we are concerned with awareness of *approaches* to learning. This issue is dealt with in the sections on learning strategies.

2.6 Summary: What Informed the Design of Mr. Collins?

Five issues in second language acquisition are important to this implementation.

Performance in the target domain.

- Empirical studies (1 - 5, to be described in chapter 4) are necessary to discover the range of errors made by students.

- Results of these studies each provide *one aspect* of the information available to help the system in diagnosis.

- Common errors should enable the creation of stereotypes.
  Learners will not actually be assigned to a particular stereotype, but 'stereotypical information' will be checked first by the system, when trying to account for a particular error.

- Less common difficulties will be stored separately in the system, and referred to after consultation of stereotypes (if there is no other information in the student model to use as a starting point).

Language transfer

- Separate models of learners' native languages will be included in the student model.

- Separate models of learners' other foreign languages will be included in the student model.

- Empirical studies (2 & 3) determine which languages to include.

- A method of determining the correct source of transfer when there are multiple possibilities must be available.

Acquisition sequence

- An empirical study (1), will help determine the typical sequence of acquisition of rules, across learners.

- The typical acquisition order will *not* be used to inform instructional sequences, but to *help determine the most likely representation for the student model* at each stage (i.e. the information is relevant to inter-language evolution and diagnosis.)

- The student model will be in the form of a continuum, following the acquisition sequence.

Learning strategies

- There must be provision for a range of learning strategies to be implemented, to allow for individual approaches to learning.

- O'Malley & Chamot's (1990) classification of learning strategy use will be used.

- The focus should *not* be on strategy training. Therefore a further classification is required in addition to that of O'Malley & Chamot, in order to advise students with reference to their individual approach.

Language awareness

- The development of awareness of language form will require information to be stated explicitly.

- Awareness of different approaches to learning will require the availabilty of information about different learning strategies, and some method of interaction about strategies appropriate for an individual.

The design of Mr. Collins should incorporate the above factors such that the system may draw from a variety of information types concerning the student and his learning, and learning in general. At this stage we can assume the following kind of structure for the student model:

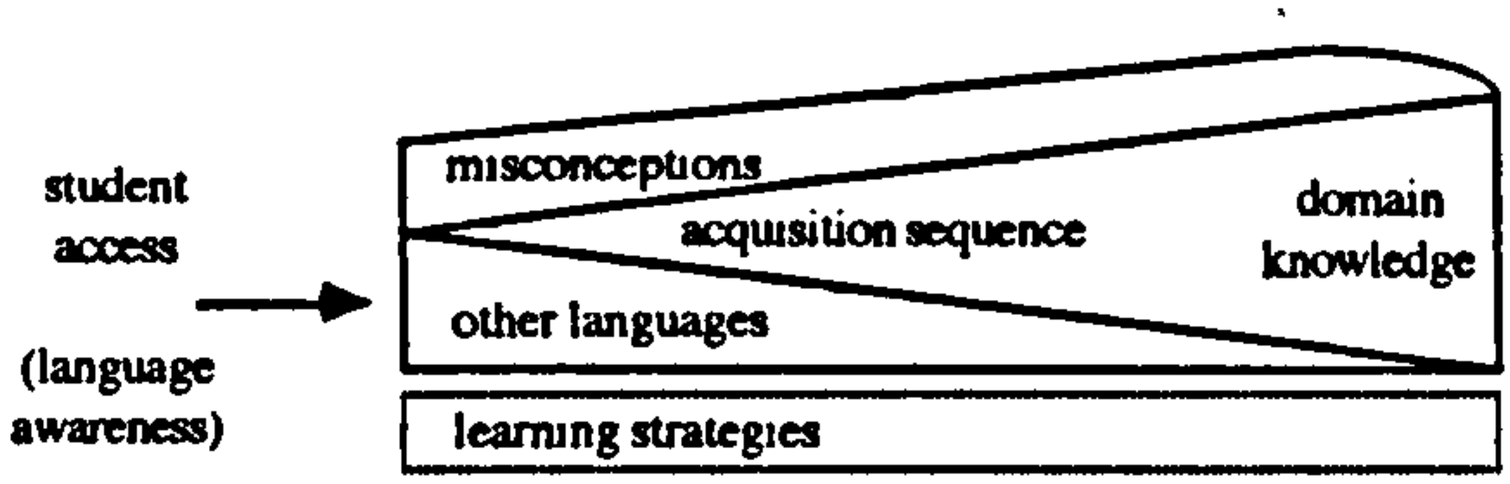

Figure 2.3: Components of Mr. Collins

Figure 2.3 demonstrates how the various components of the student model should be integrated. The *acquisition sequence* is based on the progressive acquisition of correct rules; thus as the learner proceeds from left to right along the continuum, he will be increasing his knowledge. However, he may still entertain a range of *misconceptions* which are not part of the acquisition order. *Other languages* may also feature; the reliance on these probably decreasing as the learner becomes more competent in the target language. *Learning strategies* also feature in the model; the use of individual strategies, or strategy groupings may or may not fluctuate. *Language awareness* is outside the actual structure of the student model: by allowing the student access to all components, awareness of the language and of the students's own approaches to learning, should be raised.

We now leave behind the language-related discussion, to consider collaborative student modelling in general terms.

Chapter 3

Towards Collaborative Student Modelling: taking account of *what the student says*

Self (1991) argues that 'a student model does not have to be completely accurate to be useful'. While agreeing with this statement, this thesis seeks to increase the accuracy of the student model by a method which *itself* aims to enhance learning. Chapter 2 showed one approach to improving accuracy, that of paying attention to *how* students learn the domain. Chapter 3 considers a second aspect: allowing the student himself to contribute information to his own student model. This process of student involvement combines with the aim of promoting learner reflection, and, in this implementation, language awareness.

Dillenbourg (1992) warns that 'the availability of reflection tools does not guarantee that users do indeed reflect on their learning experiences'. To promote reflection it is necessary to engage the student's curiosity. People have a naturally inquisitive attitude towards information about themselves, therefore opening the student model to the student would seem an ideal way to set about encouraging learner reflection.

In this chapter we discuss whether there really are benefits to allowing students access to their own student models. Although unusual, this notion is not new: a few examples of systems with inspectable or modifiable user models will be presented. However, it will be seen that there are differences between existing models and the approach suggested for Mr. Collins.

The crucial question therefore, is whether a student model should be available to student viewing and modification. Firstly systems allowing user-provided data for modelling are considered. A few inspectable user and student models are introduced, and user-modifiable models are discussed. Finally suggestions about how viewable student models may be used to promote reflection

are offered, before turning to the implications of the findings, for Mr. Collins.

3.1 Interactive, Inspectable and User Manipulable User and Student Models

Traditionally student models have been system-inferred, and it is therefore inevitable that they may sometimes be inaccurate. Cumming and Self (1990) suggest:

> Learner modelling in the collaborative IES [intelligent educational system] can be a shared activity, with the learner model even being open to inspection and change by the learner.
>
> (Cumming & Self, 1990: 85)

Further, Self (1991) suggests

> For example, if the student model indicates that $B_C B_S P$ and $B_C B_S \sim P$ [ie. a contradiction], then it may be more rational for the ILE to conclude nothing (let alone embark on a risky reason maintenance exercise) except perhaps that one or both is wrong and to discuss the issue with the student. Similarly, if the student model indicates that in the current problem-solving situation one of a number of rules could have been applied, rather than attempting to second-guess, . . . an ILE might do better to enter a meta-level where it is discussed explicitly.
>
> (Self, 1991: 40)

What happens if the student himself is allowed to contribute information? Are his suggestions reliable? If not, to what extent might this matter?

Interactive user models are here defined as models which use information elicited from their users, for clarification.

Inspectable user models are viewable by their users, and may or may not be interactive (in terms of the above definition).

Manipulable user models permit or encourage the user to edit their model.

3.1.1 Interactive User Models

In *user* modelling (i.e. where the user is not necessarily a student), the question of reliability of user-provided data may be less controversial. For example, in some systems, if the user changes his mind he may simply inform the system of this fact. Rich's (1983) Grundy system is an example of a system which uses information provided by the user, about his preferences. Grundy is designed to help users to select novels to read. Grundy asks users to provide words to describe themselves, in order that it may match these to stereotypes, and thereby suggest suitable reading matter for an individual. In TAILOR, a text generation system (Paris, 1993), the user may also be asked a number of questions in order to obtain some information for the initial user model. UMFE (Sleeman, 1985) questions the user about his understanding of concepts in order to provide appropriate explanations. Cohen et al (1994) argue for clarification dialogues with the user when resolution is required for disambiguating user plans, in cases where the ambiguity might matter.

Dickson (1995) states that 'the computer cannot differentiate between the student making a mistake through carelessness as opposed to an error through ignorance'. This is true in the context of traditional CALL, as was the focus of Dickson's paper, however, it is not necessarily impossible for a computer system to resolve such difficulties, albeit with outside help. As in Grundy (Rich, 1983), an intelligent learning environment may also ask the student for further information where data may be ambiguous. Chanier et al (1992) propose asking the learner whether he would accept a particular utterance as correct, in order to help disambiguate potential conflicting explanations of his behaviour. A similar approach occurs in IEGRED (Jiang & Richards, 1993), where, if a user's input results in a tie for potential template analyses, the system presents the student with training sentences, requesting him to indicate which he believes applies. In this system, this is simply a way to resolve competing system hypotheses. However, such interaction could also be used in other positive ways. ALICE (Cerri, 1989) carries out a diagnostic dialogue with the student, where translation sentences targeted at the identification of specific difficulties are presented. Again, this type of approach could be developed further to explicitly encourage learners to reflect more deeply on the differences between translations (in ALICE the focus is the use of conjunctions in English, French and Italian).

EPIC, a tutor for propositional logic (Twidale, 1990), is an attempt to improve diagnosis through allowing the learner to explain his reasoning to the system via an interface offering menu options, form filling possibilities and text annotation, to articulate his plans and rule instantiations. It was found that useful diagnoses could be performed based on the student-provided information. This type of approach in educational systems may overcome difficulties such as noted by Dillenbourg (1995) for MEMOLAB, where erroneous assumptions of the expert about the student's intentions could not be corrected by the student.

Remaining on the subject of intention, Johnson (1988) suggests using a framework for the explicit description by programmers, of their intentions, in order that non-syntactic bugs in program code (in PROUST) become easier to identify. Johnson argues that programmers should be able to describe their intentions, as happens with the Bridge programming tutor (Bonar & Cunningham, 1988). Similarly, Genesereth (1982) suggests asking the learner about his plans, and QUIMON (Feurzeig & Ritter, 1988) uses information elicited from the learner regarding his intentions, actions and plans.

An experiment with PROBIT (PROBability Intelligent Tutor: Or-Bach & Bar-On, 1992) revealed that requiring students to provide explanations of their answers, and also examples of possible errors which could be made, helped to differentiate between competing hypotheses about the cause of an error, as retrieved from the misconceptions library in the system. Sleeman and Hendley (1979) describe ACE, a system allowing students to provide natural language explanations - the system analysis of which is paraphrased back to the student to afford him the opportunity of either accepting the system's interpretation, or rejecting it and reformulating it for the system to tackle a second time.

In summary, the main contribution of interactive user models has been to lighten the burden and responsibility on the system, of modelling the student. The potential exists for causing learner reflection during this process, but there is no guarantee that this will occur.

3.1.2 Inspectable User Models

Dillenbourg (1992) argues for the role of the computer as 'constructorium'; a tool enabling students to observe their own learning. Dillenbourg states: 'in this case, making learning observable means showing the learner some representation of how they have learned'.

The next step, after providing the facility for users to contribute information about themselves, would seem to be enabling them to *view* their own models. A few models open to inspection have been discussed in the literature. The minimal version of an inspectable model could be seen as a simple system analysis of student performance, presented to the student once diagnosis is complete. Although this is not strictly a case of making the student model accessible - the system has control over what is described and the timings of descriptions - it does, nonetheless, provide a description of the student's performance and difficulties. This type of information is provided in the ALICE system described above (Cerri, 1989).

More detailed information is provided by DARN (Discovery And Reflection Notation - Schauble et al, 1993). There are three graphical views constantly available, relating to student activity in self-directed experimentation: a linear trace of the activity; plans (including relevance of plans); the expert view. DARN is aimed at helping students reflect (though recall Dillenbourg's statement: *the availability of reflection tools does not guarantee that users do indeed reflect* (Dillenbourg, 1992)). This is again not a 'true' student model[1] in the sense that it does not portray representations of the student's *knowledge state*.

Similar to the activity trace of DARN is Bio-world's diagnostic notebook (Lajoie, 1993). This is likewise not strictly a student model, however, students' previous actions are presented in order to support reflection. HERON, a system for mathematical word and story problem solving (Reusser, 1993) uses graphical solution trees. Reusser supports this approach with a number of claims; the three most relevant here being:

- they are transparent, self-explanatory, and visually inspectable cognitive instruments for representing, evaluating, and communicating the processes of understanding and solving a large class of word problems;

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1 This is not a criticism, but an observation!

- they illuminate the hidden construction process by which the student determines the structure of problem situations;
- in so doing they make students' thinking overt and accessible to discussion[2].

(Reusser, 1993:162-163)

The most well known of approaches similar to those described above, are probably Algebraland (described in Collins & Brown 1988) and the Geometry Tutor (Anderson et al, 1985). Again, in these systems reflection is encouraged through graphical representations of the problem solving process. However, it is not crucial to interactions if there is no reflection, as the systems will not be aware of this.

A closer approximation to an inspectable student model is Corbett and Anderson's (1995) skill meter in the ACT Programming Tutor. The skill meter is available in order that the tutor's model of the student's knowledge is accessible to the student. It is in the form of a bar graph, indicating the probability that the student knows each rule represented. It appears that high school students who have used the tutor often learn algebra as a means to gain check marks on the skill meter, rather than to actually learn algebra for its own sake![3] (Corbett, personal communication.) However college students appear to use the skill meter differently, primarily viewing it as an indicator of the amount of time or number of exercises remaining.[4] The skill meter does not, of course, represent all information in the student model, for example it is much less detailed than the information available through DARN. However, it is a useful way of displaying a summary of current performance levels, which could be helpful for the student. As stated above, two different uses of the skill meter by students have been noted.

Pilkington et al (1992), in their description of a dialogue game interface for systems which are able to challenge and defend arguments, state 'the interface displays the commitment stores of both participants and all the moves made so far'. Thus both players know their own, and the other's commitment set. This is similar to the notion of an inspectable student model. Indeed, there is a more central role for these visible commitment sets, as arguments by either party must necessarily be made with reference to the sets.

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2 Discussion between two students using HERON.

3 This is an informal observation, and has not been directly investigated.

4 This is based on a questionnaire survey of 12 novice programming students (Corbett, personal communication).

A similar notion of displaying learners' own and other partners' views is offered by Hoadley and Hsi (1993) in the Multimedia Forum Kiosk (MFK). The aim of MFK is to 'encourage learning through community discussion', in the form of reflective discourse. There is an *opinion area* to provide 'an overview of the community perspective' to which each user may add one comment, and an *argument map* to indicate the structure of the various opinions offered. (This is achieved by requiring users to supply a classification label to their contributions: elaboration, critique, alternative, question, rephrasing, new idea.) Users must be aware of the general opinions in order to submit their own. The argument map in particular could be viewed as a multi-user model, the contents of which are the focus of all users.

Although it does not contain a student model, Integration-Kid (Chan, 1991) uses a learning companion:

> . . . the companion's behaviour can be viewed as a form of active student model. The companion uses a similar language to describe the problem, shares the same view and feeling, and shows sub-optimal performance in solving it which might have been a probable error by the student himself. Rather than [being] used by the teacher, it interacts explicitly with the student and reflects to the student an image close to him.
>
> (Chan, 1991: 1096)

Although the notion of an inspectable student model is interesting and potentially very beneficial to learners, for it to be effective in its promotion of reflection learners must actually view it, and think about its contents. Barnard and Sandberg (1996) found that the simple existence of an inspectable student model was often insufficient to entice students to view the information. Allowing students some degree of control over the contents may help to overcome this.

3.1.3 Manipulable User Models

User models which are *modifiable* by the user (i.e. may be altered at will), have also been implemented. For example, Orwant (1994) presents the DOPPELGÄNGER user modelling system, which includes an interface to enable users to view and correct the user model. Orwant claims that it is necessary to provide a facility for systems to explain their user models, and allow users to alter them if they are to have faith in them.

Cook and Kay (1993; 1994) describe a user model (um) which, through a graphical tree structure, is accessible to user viewing. Moreover, the system is able to justify the contents of the user model. The user is able to alter the contents of the model where these are felt to be incorrect, through use of the um viewing tools. The user may here also offer information directly (as well as as a result of a system request for information (Kay, 1994)). The system may override user-provided information in cases of disagreement.

In *student* modelling the situation is complicated. The aims of a system embodying a student model must, except in very few cases, include the assumption that students should *learn* while using the system[5]. Thus, an educational system with an approach which in some respects resembles systems such as Grundy, must ensure that explicit interaction with the student about his knowledge or preferences does not interfere with learning. Individuals using Grundy are expecting a book recommendation which suits their interests. With an intelligent learning environment, a student wants (or needs) to learn, typically through some kind of exposure to the target domain. For a collaboratively maintained student model to work, the learner must view interaction about his beliefs concerning the domain as contributing to his learning. In addition, as Dillenbourg (1995) states of *mutual diagnosis:* 'the interactions conducted to clarify what the learner believes will tend to affect what she believes'. This will, in turn, affect the contents of the student model.

The model of Cook and Kay (1994) mentioned above is claimed to have some educational benefits: users are aware of the size of the domain, and are able to select more easily what they wish to learn within the domain (the sam text editor). However, as users may alter their user models, in an educational setting this may result in an incorrect student model (see Kay, 1994). Cook and Kay (1993) state that users were interested, viewed and understood their user models and, of those who viewed it frequently, most made some changes in the model. Such direct intervention in the user model may be less desirable when the user is a student, because although students can supply information about their knowledge, they will not necessarily always be right. (Nevertheless, the fact that they can express an opinion may provide useful information to the system about their beliefs.)

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5 See Pain et al (1996) for a justification of creating a student model 'for its own sake' (though even here some degree of learning is likely to occur).

Self (1988) suggests that it might be useful for a student to know what the system's representations about that student are, as this may lead to greater *learner reflection.* This is also one of the reasons offered by Paiva et al (1995) for externalising the contents of the learner model, and a main motivation for inspectable student models argued by Crawford and Kay (1991).

Pilkington and Ravenscroft (1993) propose allowing a 'common model' (i.e. common to system and student) of the domain to be run in order that the learner may reflect on the difference in the expectations he has of the student model, and its actual behaviour. A different usage of a runnable student model is made by CONVINCE ME, a system 'to help people articulate, structure, and evaluate their theories and arguments' (Ranney et al, 1993). After inputting, categorising and indicating the likely reliability of their beliefs, students' arguments are simulated. Learners may then alter the structure of their argument, or adjust the ECHO connectionist model of the *Theory of Explanatory Coherence*[6] in order that it becomes closer to their particular style of reasoning (see Ranney et al, 1995).

3.1.4 Related Research

Other research is also relevant; Pienemann's (1992) COALA system performs semi-automatic analysis of interlanguage. The researcher is left to analyse parts of the data collected in order to complete the full analysis. In some sense this is similar to the notion of a student contributing information to the student model; however here the researcher is providing additional information about *another* person's interlanguage (for research purposes). IFAAR (Interface for the Acquisition of Applicable Rules - Chanier & Pengelly, 1991) allows experts to explain students' errors, information which may then be used in learner modelling. Student explanations of their own and other learners' behaviour is also proposed as a useful perspective on student modelling (Chanier et al, 1990).

Mizoguchi (1993) claims there to be a trade-off between the acquisition of reliable student models and the provision of prompt feedback to the learner, as it takes time to accumulate sufficient information to enable optimum individualisation through the representations constructed in the student model. With reference to the

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6 See e.g. Ranney et al (1993); Ranney and Schank (1995) for the ECHO model.

above discussions and their implications for collaborative student modelling, it will be suggested that this trade-off may be at least partially overcome, while at the same time bringing additional educational benefits to the student.

3.2 Implications for Mr. Collins

At the start of this chapter it was suggested that the student model could be usefully opened to student inspection and modification as a source of information for learner reflection. The possibility of the student contributing inaccurate information has been raised, but not yet answered. The possibility of learners not consulting their models has also been suggested. In this section, issues surrounding requirements for collaborative student modelling as implemented in Mr. Collins are discussed, including the 'problems of unreliable or disinterested students'.

3.2.1 Conflict Resolution

Collaborative student modelling implies attempts at the resolution of conflicting beliefs. This will reduce the need for imprecise representations such as are used in some systems (e.g. TAPS - Hawkes & Derry, 1989; LICE - Bowerman, 1992). In student modelling there are bound to be inconsistencies, as the student is (presumably) learning, and perhaps also forgetting. Although this is a general problem for student modelling, some systems have focussed particularly on the area of conflict resolution (e.g. Mizoguchi et al, 1993; Aziz, 1996). In UMFE (Sleeman, 1985) the method of resolving contradictions in student and system beliefs is simple: information provided by the user is considered more reliable than system inferences. Aziz (1996) describes the process by which inconsistent student beliefs (having the same weighting) are contrasted, leading to the eventual weaker belief becoming decremented; this is a more complex procedure involving comparison of justifications, learners' responses to questions and the number of correct responses applicable to each of the competing beliefs. However, resolution of system vs student beliefs is simpler: the system's beliefs are always considered correct. Unlike in UMFE, the user is not directly asked questions to help resolve the situation, hence the necessity for greater complexity in the resolution process.

In a collaborative approach to student modelling which, as in Mr. Collins, aims for an accurate student model while also promoting learner reflection, it would seem that some combination of approaches such as described by Sleeman and Aziz would be necessary. Because of the possibility of the learner being wrong, simply allowing him control over the contents of the model may result in the model containing inaccurate information. Nevertheless, when the aim is to use the student model to enhance reflection, some input to the model by the learner is desirable, as this would seem the obvious way to 'ensure' reflection. The system must have some means of determining what it believes to be the appropriate information to include in the student model, in order to judge whether the learner's contributions are correct. This leaves us with two perspectives: the learner's beliefs, and the system's beliefs about the learner. A method is required to overcome any discrepancies between the two. The central question is: who should have ultimate control? The answer to be offered by Mr. Collins is: *both*. The system should have control over the representations of its own views, and the learner should be in control of the representations of his beliefs. This implies a dual representation in the student model for each belief; that of the system about the student, and that of the student about himself. A process of negotiation will be necessary between the two parties in cases where a pair of belief measures is incompatible. This negotiation should serve to promote learner reflection as the learner will be reviewing and discussing his own beliefs, resulting in a greater degree of accuracy in the model. However, some facility to record disagreements must remain available if the learner and system cannot agree. This will avoid the need to allocate one partner ultimate control over the representations. If negotiation can be initiated by the system as well as by the student, learners will probably be more likely to view the student model than they might if the system were to overlook conflict unless discussion was introduced by the student.

3.2.2 Learner Contributions to the Student Model

The literature surveyed in the previous section leads to an assumption that a more structured, collaborative student modelling approach would be useful. However, there are no results as to the effectiveness of such an approach, as the main aim of the few systems which consider this tend not to be the promotion of reflection. For example, Paiva et al (1995) use the externalisation of user models to provide information to a variety of outside agents, the user being just one of these.

Although promotion of learner reflection is one suggested use of their TAGUS model, this was not the primary focus of work on TAGUS. A study is therefore needed to determine the feasibility of collaborative student modelling.

The initial questions of this chapter were as follows:

- What happens if the student himself is allowed to contribute information?
- Are his suggestions reliable?
- If not, to what extent might this matter?

Learner contributions to the model may obviously alter its contents. By providing a student model with two possible representations for all beliefs, it is less crucial that information provided by the student is correct. Moreover, for the functioning of the system it does not matter at all if learner contributions are inaccurate; indeed, interaction about this may help to clarify things for the student, or help the system to better understand the student's perspective.

3.2.3 Negotiation in Student Modelling

The type of student model proposed for Mr. Collins is *interactive*, *inspectable* and, within constraints, *user manipulable*. Thus, in common with systems such as Grundy, TAILOR and UMFE, Mr. Collins will ask students direct questions to help clarify ambiguity. Moreover, because Mr. Collins embodies a truly collaborative approach, students should also have the facility to question the system about its inferences about their beliefs. In addition, Mr. Collins should provide learners with analyses of their performance and misconceptions as occurs in ALICE, but such information should also be accessible *whenever the learner wishes to see it*, as with the ACT skill meter and DARN. Some way of ensuring that learners really do use the information offered as a basis for reflection is also desirable. This can be achieved by allowing the learner to edit their model as occurs in um, but with reactions from the system to the student's actions in their student model, requiring them to justify their decisions if the system disagrees. It was stated above that, because there are two equally valid sets of beliefs in the student model, some form of negotiation is necessary to help resolve inconsistencies (and promote reflection).

A detailed account of the use of negotiation in an ILE has been given by Baker (1990), and a model of negotiation for educational dialogues is also offered (Baker, 1994). For Mr. Collins a less sophisticated method is adequate, and indeed, preferable. Students are not expected to be negotiating all the time; only when there is a conflict of beliefs about the student's learning. Negotiation should not become a central aspect of the interaction; it should be used simply to help resolve inconsistencies between the student and system's perspectives. Therefore, in order to ensure that as little disruption to the student's learning occurs as possible, negotiation through menu format is recommended. Learners will then appreciate the range of options available, and will not need to spend time typing (in a restricted language which must be learned), or making choices which may not be available.

Baker (1992) offers the following as typifying the kinds of utterance occurring in negotiation:

- question/answer
- offer/acceptance/rejection
- utterance/acknowledgement
- elicitation/response
- request/response
- statement (belief, goal)
- explanation
- justification

As stated above, for Mr. Collins a different approach to that of Baker, is proposed. This is not only because negotiation itself is not the focus of the main interaction - *teaching* is not undertaken in negotiated format - but also because Baker's (1994) view of negotiation is concerned with *acceptance* rather than belief. In Mr. Collins it is precisely *beliefs* which are the object of negotiation. If resolution is not possible, acceptance will not occur (a student will not accept that they believe X unless they actually *believe* they believe X). Nevertheless, the above distinctions are still useful in the context of Mr. Collins since they are concerned with the 'mechanics' of negotiation.

Additionally, despite the differences between the two uses of negotiation, a major feature of Baker's approach is relevant here: the issue of *symmetrical rights*.

As the intention is that a student using Mr. Collins will be negotiating the student model, i.e. negotiating about his beliefs, he must be allowed some control over the representations to be contained in the model. However, as negotiation is a two-way process, the system must have equal power. As considered above, this suggests a dual representation for each entry in the student model: one ultimately under the control of the student, and the other ultimately controlled by the system (for cases where the two parties cannot agree). Symmetrical rights concerning the initiation of negotiation are also important.

Negotiation in this context does of course imply that students are able to negotiate with a system, understand what they are negotiating about, and be able to state their beliefs and confidence in their beliefs. Furthermore, in addition to being able to do the above, they should also actually do it! This needs to be investigated before collaborative student modelling can be developed to the full.

The issue of confidence has been used in other systems, for example, del Soldato (1992). Our use differs from that of del Soldato in that her concern with confidence was to achieve more appropriate teaching actions. The focus of Mr. Collins is student modelling, and while del Soldato's approach of measuring confidence and effort to decide how to optimise motivation could be useful in a Mr. Collins tutoring component, as stated above, we are here concerned with user/system discussion of confidence primarily as a means to promote reflection.

Payne and Squibb (1990) found that their subjects (13 - 14 yrs) had in some cases high confidence in their incorrect responses. In contrast, Lajoie (1993) states of a study on grade 9 high school students that '... there is a significant relationship between how confident one is and how accurate one is ...' Lajoie's results might suggest a relationship between confidence and performance. However, given Payne and Squibb's results, this cannot be assumed to always be true. Therefore, for Mr. Collins it is important to determine whether students in this context are able to assess their own answers for correctness, and moreover, not only the accuracy of their self-assessments, but also whether they are prepared to consider revising their assessments if challenged. Hence studies are needed[7] to:

- confirm that students are willing and able to state their beliefs;

[7] These studies are described in chapter 4.

- identify students' levels of confidence in their answers;
- assess their willingness to alter answers if their beliefs are challenged;
- identify if there is a relationship between the strength of a student's belief and willingness to alter it.

3.2.4 Summary

Figure 3.1 shows the three types of student model discussed in this chapter, in relation to each other and to student models in general.

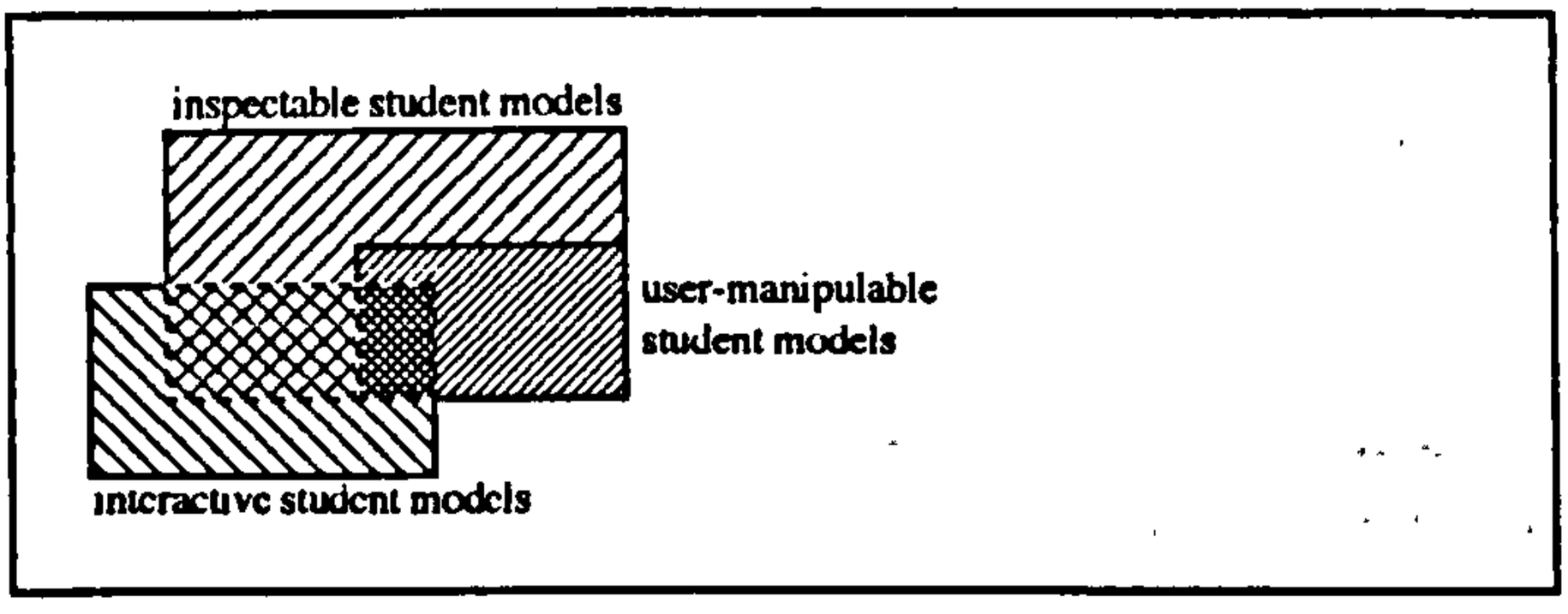

Figure 3.1: Interactive, inspectable and manipulable student models

The large outer box portrays the space occupied by all student models. Within this area we find our three special cases of student model: inspectable student models, which form the largest subcomponent of this group of three model types; interactive student models which may or may not be inspectable; and user-manipulable student models which must be inspectable, and may or may not be interactive (as defined here). Mr. Collins rests in the space of a user-manipulable student model (and therefore also inspectable), overlapping with an interactive student model.

Two points of view must be represented in the model: that of the student, and that of the system about the student. Each perspective should be considered equally valid. Chapter 4 addresses the SLA issues introduced in chapter 2, and the student modelling questions raised here in chapter 3, synthesising these into an implementation of a collaborative student model. Collaborative student modelling aims for a more accurate student model, while at the same time enhancing learning through the promotion of reflection.

Chapter 4

Mr. Collins

In chapter 2 some of the issues involved in language learning, and attempts to deal with these by various language learning systems, were described. It is not sufficient for example, to note what types of error occur in the domain without trying to determine the possible underlying misconceptions. For instance, in our case of Portuguese, the sentence **os compra* (*compra-os* = he buys them) could occur as a result of overgeneralization from another Portuguese rule such as that applicable in negative clauses or open questions, or as a result of transfer from Spanish, Catalan or French. Even systems which use machine learning techniques to construct the student model should be able to understand, rather than simply identify, the underlying misconceptions causing the errors which they diagnose. Because of the importance of such questions, implications for the implementation of Mr. Collins were given in chapter 2, and it is from this point that we now continue with a description of the Mr. Collins student model, which was designed based on the issues raised earlier. Section 4.6 then describes the collaborative student modelling approach suggested in chapter 3, which has for this implementation been built on top of these linguistic issues. Unless explicitly stated, all points described have been implemented.

4.1 Performance in the Target Language

Performance, as judged against the target rules, can be correct or incorrect. It is recognised that 'incorrect performance' is an inevitable part of learning a foreign language; a phenomenon to be expected from even the most 'gifted' learners as errors are a natural part of the acquisition process. Therefore the term 'error', as used here, should not be seen as a negative aspect. In the discussion to follow errors will be the focus, rather than correct performance: if a learner is performing well and is also confident in his work, there will be no need for system intervention. However difficulties are commonly manifested as some kind of error;

hence the preoccupation with this phenomenon in this section. (Other aspects of learning are dealt with in later sections.)

In section 2.1 it was stated that there has been a lot of work on student errors in language learning. Section 2.1 also indicated that some (though far from most) designers of CALL systems undertake empirical studies to determine the types of problem encountered by the target users. This is useful if a program is to be maximally effective. There is still a place for many of the more rapidly constructed programs which do not rely on empirical evidence, as such programs can be used to develop automaticity if used at the right stage, and can be put into practice quickly. However, these systems cannot claim complete coverage of errors, and their approach to error management remains ad hoc.

4.1.1 Errors Handled by Mr. Collins

This section discusses the more traditional aspect of the student model, that part concerned with modelling a learner's knowledge and misconceptions. As stated above, if a system is to successfully model learner performance it should know the likely errors and where possible also their causes in order to manage the interaction in the most appropriate manner. Regardless of the theoretical approach to student modelling adopted in a system, in the early stages an empirical study of students' difficulties in the domain should be referred to in order to ensure the validity of the student model and explanations offered based on the contents of the model. Such a study, used to inform the design of Mr. Collins, is described below.

STUDY 1

The example domain described in this thesis is a particularly complicated area in European Portuguese; there are a variety of different problems which can arise. In order to identify the range of pronoun errors committed, and their relative frequency, a study of 47 undergraduate students of Portuguese (i.e. the target users), was undertaken. Most learners were native English speakers who knew Spanish, and many had also previously learnt French. They were beginners in their fourth week of Portuguese when the study began. The course consisted of 3 taught hours per week - 1 hour of grammar and 2 hours of conversation/exercises. (Other aspects of this study are described in section 4.3.)

Method

The study was carried out over 5 weeks, and was based on (paper and pencil) multiple choice, translation and sentence transformation tasks. All errors made by students were recorded. The tasks were given as homework[1,2], therefore all errors still occurred despite free access to the class grammar notes (Frier, 1992), which covered all information necessary for correct performance. The study was then supplemented by a revision test taken by 13 of the 47 students, providing further examples of errors (see appendix B).

Results

Four main types of pronoun related error were identified. These involved:

1. sentence structure;
2. the pronouns themselves (including both incorrect pronoun selection, and errors in phonetic contractions);
3. hyphens;
4. problems of pronoun placement.

In order to understand these errors, it is first necessary to briefly describe the use of personal object pronouns in European Portuguese.

The forms of the direct object pronoun are:

1st person singular:	me	1st person plural:	nos
2nd person singular:	te	2nd person plural:	vos
3rd person singular:	o/a	3rd person plural:	os/as

---

1 Some students did not hand in homework every week.

2 Thanks are due to David Frier for providing copies of the students' weekly homework exercises.

The forms of the indirect object pronoun are:

1st person singular:	me	1st person plural:	nos
2nd person singular:	te	2nd person plural:	vos
3rd person singular:	lhe	3rd person plural:	lhes

(The forms *você, vocês, o senhor, os senhores, a senhora, as senhoras* are not currently used in the system.)

There is also a combined form of the object pronoun, which applies when indirect and third person direct object pronouns come together. These are as defined below:

DO pronoun:	*o*	*a*	*os*	*as*
IO pronoun:				
me	mo	ma	mos	mas
te	to	ta	tos	tas
lhe	lho	lha	lhos	lhas
nos	no-lo	no-la	no-los	no-las
vos	vo-lo	vo-la	vo-los	vo-las
lhes	lho	lha	lhos	lhas

The indirect object pronoun always occurs first, thus *me + o* --> *mo*, etc. Note that it is not possible to distinguish between *lhe + o* and *lhes + o*, as both are realised as *lho*. Similarly *lhe + a* and *lhes + as* are indistinguishable, as are *lhe + os* and *lhes + os*, and *lhe + as* and *lhes + as*.

There is a further type of pronoun in addition to IO, DO and combined pronouns: the disjunctive pronoun. Disjunctive personal pronouns are 'strong' pronouns (see Willis, 1984). When a weak, first or second person DO pronoun

comes together with a weak IO pronoun, the IO pronoun used is the strong form[3], and is preceded by *a*. The disjunctive object pronouns are as follows:

1st person singular:	mim	1st person plural:	nós
2nd person singular:	ti	2nd person plural:	vós
3rd person singular:	si/ele/ela	3rd person plural:	si/eles/elas

(*si* is the reflexive pronoun, and *ele/ela/eles/elas* are non-reflexive. There is no distinction between reflexive and non-reflexive strong object pronouns in the first and second persons.)

Figure 4.1 shows the non-placement error types which were observed, together with a measure of their frequency.

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3 Disjunctive pronouns are also used after prepositions, such as *para* ('for'), and *entre* ('amongst').

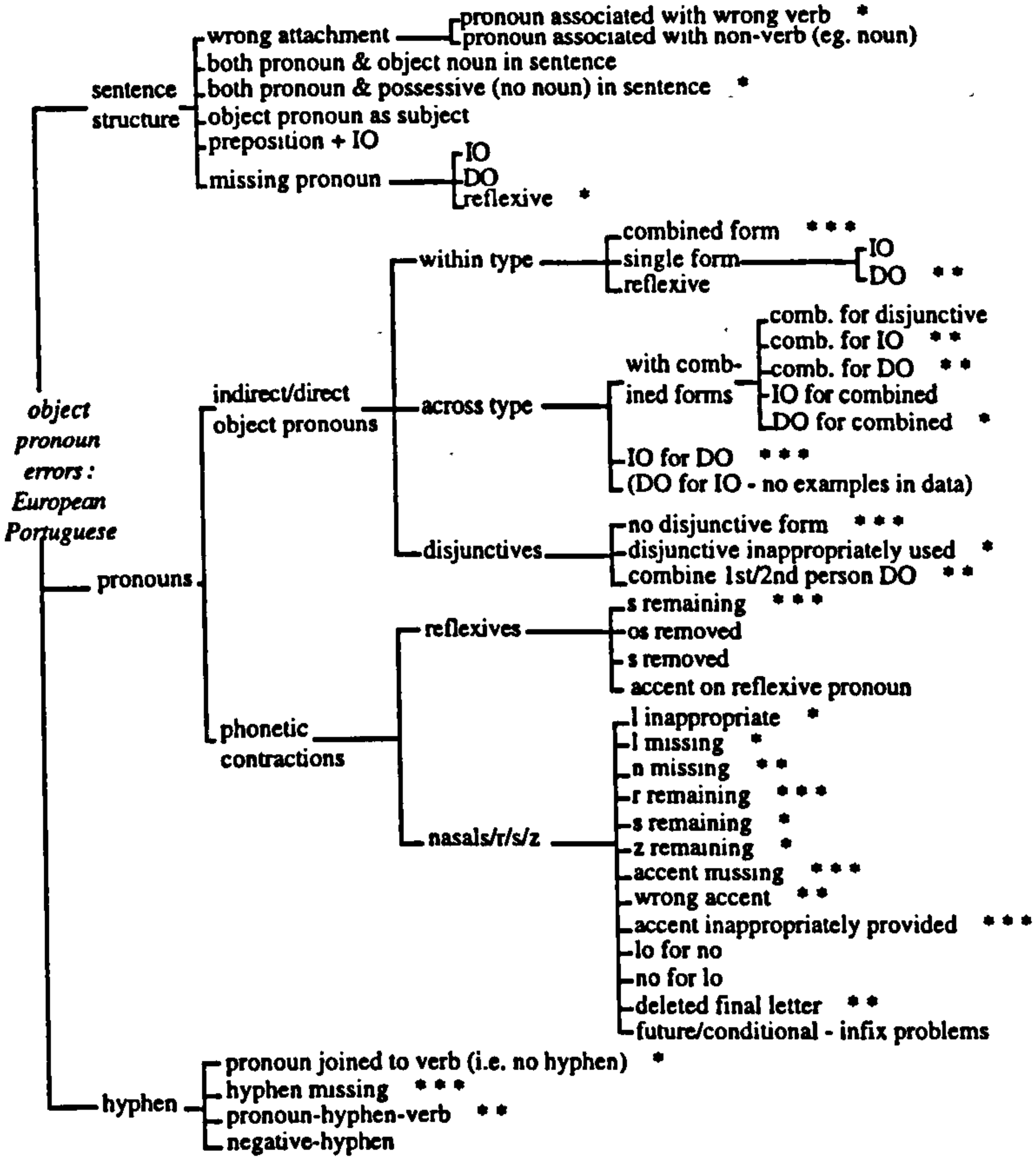

Figure 4.1: non-placement errors observed amongst students

Key: *** = very frequent[4] (at least 25% of students have made this error at least once)
** = frequent * = occasional no asterisks = one or two isolated occurrances
IO = indirect object pronoun DO = direct object pronoun
(Where both IO & 3rd person DO occur, these join to create one combined form (e.g. o [it] + lhe [to him] becomes lho)

The most common of the error types in figure 4.1 are outlined below, with examples from the data collected. The full set is given in appendix C. Where

[4] Most frequent in the sample data. At this stage this should be viewed as a useful starting point, and not as a definitive description of possible errors and their relative frequencies.

possible the same target sentences have been used to demonstrate errors, in order to illustrate the variety of problems occuring across the same exercise sentences. As can be seen from the data, various error combinations are possible. Because multiple errors can appear in the same sentence, the same deviant structure may appear in more than one category.

1. sentence structure

Errors recorded as errors in sentence structure tended most often to be due to a lack of understanding of the function of pronouns, or the difference between subject and object pronouns, or no realisation that a pronoun simply means *it* or *she* or *to them*, etc. A relatively large proportion of these errors were from just one student (S2 - see figure 4.3, who appeared to have no notion of grammatical functioning at all.) Among sentence structure errors were: inclusion of the object noun in the sentence in addition to the object pronoun, and omitting the pronoun (and noun) entirely.

2. pronouns

There are two types of error in this group: those involving wrong pronoun selection, and those concerning phonetic contractions. Of the first type, students may select incorrectly from among pronouns of the same kind (e.g. IO or DO or combined form pronouns), or may confuse two types and use a DO pronoun in place of an IO or combined pronoun, for example. They may also have difficulty with the usage of disjunctive pronouns.

Examples of some of the most common errors in the data in the sub-category indirect/direct object pronouns follow:

IO/DO object pronouns: within type: combined form

Não lha escreve --> * Não lhas escreve (She does not write it to them)

The incorrect combined form has been used. The target was *lhes* + *a*, which joins to form *lha*. (*Lhas* occurs with *lhe* or *lhes* + *as* - i.e. 'them', rather than 'it'.)

IO/DO object pronouns: across type: IO for DO

Quero vê-los --> * Quero de ver-lhes (I want to see them)

The indirect object pronoun has been used in place of the direct object pronoun. (Note also the use of *de*.)

IO/DO object pronouns: disjunctives: no disjunctive form

Apresenta-me a ti --> * Apresenta-me a te (She introduces me to you)

The object pronoun *te* has been used in place of the disjunctive *ti*.

We now move on to the sub-category of phonetic contractions. These will first be summarised[5], and examples of errors from the data will follow.

1. In cases where the third person direct object pronoun (*o*, *a*, *os*, *as*) follows the verb, if the verb form ends in *r*, *s* or *z*, the final *r*, *s* or *z* is omitted and *l* is affixed to the front of the pronoun (--> *lo*, *la*, *los*, *las*). In addition, when the stress is on the final syllable, or the verb form consists of only one syllable, a written accent is usually required.

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5 Greater detail is given in Willis (1984).

Thus **faz-o* becomes *fá-lo* (he does it)
and **quer saber-o* becomes *quer sabê-lo* (he wants to know it).

2. After verb forms ending in a nasal sound, third person direct object pronouns become *no*, *na*, *nos*, *nas*. (The final nasal sound is not omitted.)

Thus **têm-o* becomes *têm-no* (they have it).

3. Before the reflexive *nos*, the final *s* of the verb is omitted.

Thus **lavamos-nos* becomes *lavamo-nos* (we wash ourselves).

4. A further rule is

**Tens-o* becomes *tem-lo.* (you have it).

Examples of common errors involving phonetic contractions will now be presented.

phonetic contractions: reflexives: s remaining

Levantámo-nos --> * Levantamos-nos (We got up)

The final *s* of the third person plural form of the verb before the reflexive *nos* has not been omitted.
(Note also the missing accent from the verb.)

phonetic contractions: nasals/r/s/z: r remaining

Quero vê-los --> * Quero ver-los (I want to see them)

The student has not omitted the final *r* on *ver* (or added the accent).

phonetic contractions: nasals/r/s/z: accent missing

Quero vê-los --> * Quero ve-los (I want to see them)

The student has not remembered to add the accent to *e*, after removing the verb-final *r*.

phonetic contractions: nasals/r/s/z: accent inappropriately provided

Abri-la-emos --> * Abrí-la-emos (We will open it)

The student has provided an accent where none is required.

3. hyphen

Post-verbal pronouns are joined to the verb by a hyphen. (Pre-verbal pronouns have no hyphen.) The most common of hyphen errors is omission:

hyphen missing

Oferece-lhe o seu passaporte --> * Oferece lhe o seu passaporte (He offers him his passport)

The hyphen has been omitted.

4. pronoun placement

Pronoun placement is dealt with in more detail in section 5.3, as it is performance on this factor which is used to determine the acquisition order of the

target rules. Therefore, at this stage only the rules for pronoun placement as used in the system will be provided:

The pronoun is pre-verbal in:
negative clauses; open questions; relative clauses; subordinate clauses; after certain adverbial phrases.

The pronoun is post-verbal in:
affirmative main clauses; positive imperatives; infinitives; yes/no questions.

The pronoun is between:
auxiliary and past participle.

The pronoun is an infix in:
future tense; conditional tense.

A few errors of pronoun placement could be found in the examples listed above, however they have not been discussed. These rules, with accompanying examples, are again presented in section 4.3.1 The placement errors were identified (by the author) to be probably a result of overgeneralisation of other Portuguese rules, or a result of transfer from another language. Actual questioning of learners would provide evidence for or against this assumption.

Errors and Mr. Collins

The ICALL system currently deals with a sample of errors of types 2, 3 and 4 (phonetic contractions, hyphens and pronoun placement).

Individuals and Errors

Figure 4.1 showed the different, non-placement error types identified from the data collected. The frequency of different errors across all students was also indicated. However individuals can vary greatly. Figure 4.2 illustrates the error types made by one student: S8.

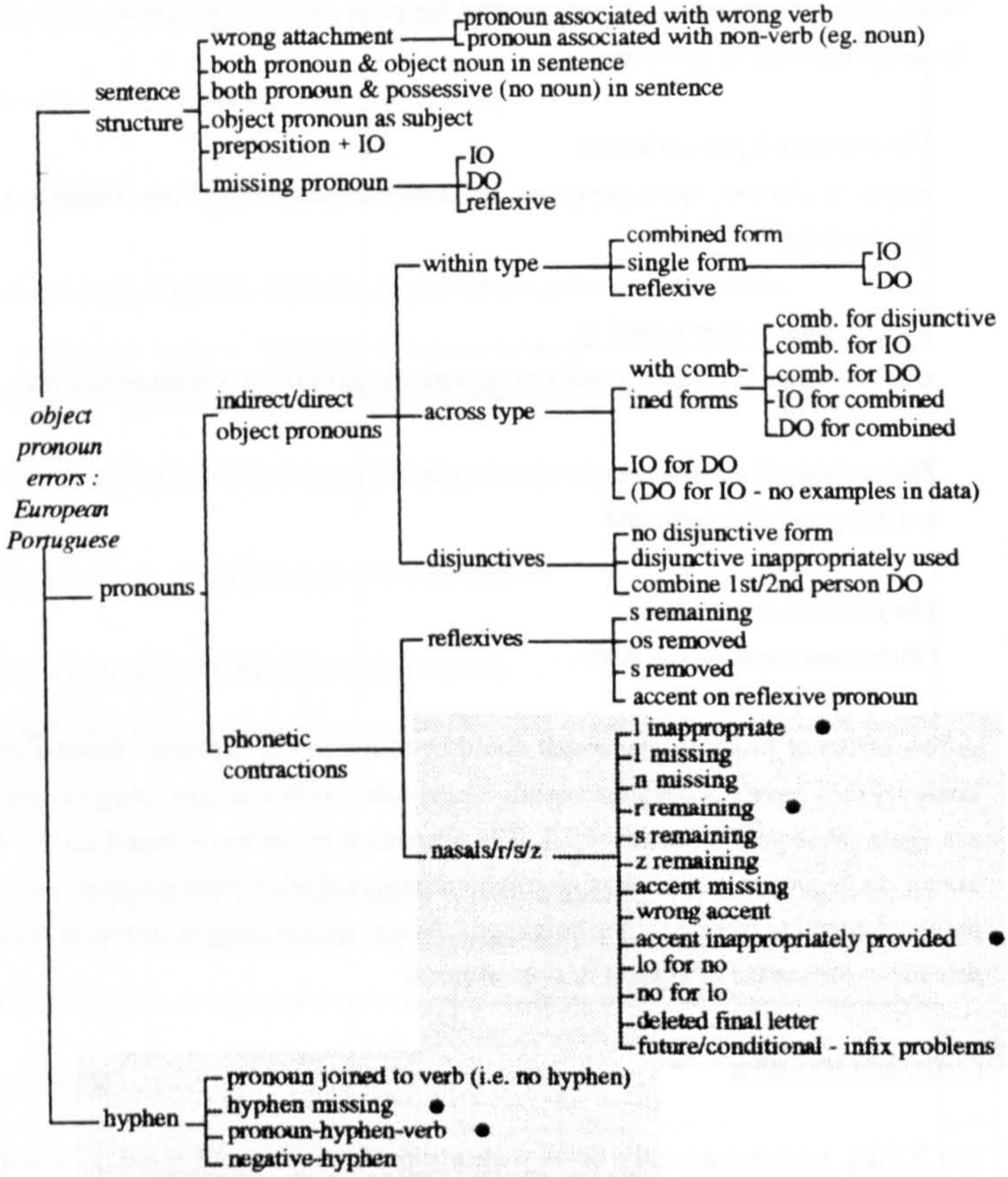


Figure 4.2: error types of S8
Key: • = error shading = sets of potential related errors

S8 tended to make some hyphen-related errors, and had a few problems with phonetic contractions. She did not have difficulties in any other areas.

The situation for other learners can be similar in the sense that there are a few specific areas of difficulty, but these are not necessarily the same as for S8. Other learners have a more even spread of errors, i.e. they produce deviant sentences containing errors from many (or even all) of the different categories. Figure 4.3

gives the extreme example of S2, who made a large number of errors across the whole range of error types.

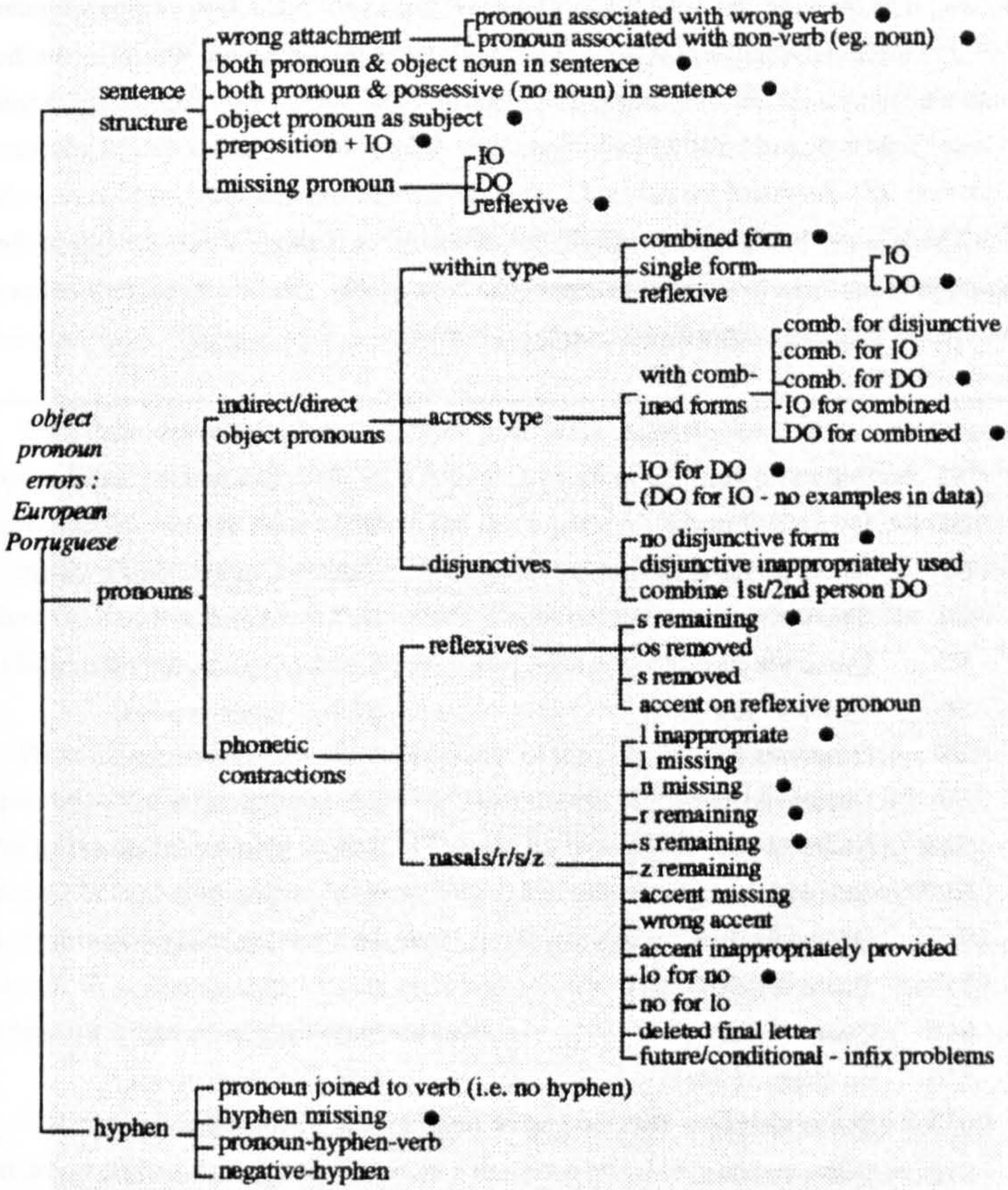


Figure 4.3: error types of S2

Multiple errors can occur in the same sentence. Across all students the most common involved the non-omission of verb-final *r*, *s* or *z*, occuring with either IO for DO or combined form for DO. Accents are often (but not always) omitted in this context, e.g. *Quero vê-los* --> **Quero ver-lhes*.

As an illustration of the variety of errors possible in just one short sentence, the attempts of each student at translating the phrase 'I want to see them' are listed below. The target is *Quero vê-los* or *Quero vê-las*; *quero* is the first person singular of the present tense of *querer* ('to want'), and *ver* is the infinitive 'to see'. As the verb ends in *r*, this must be omitted before the third person DO pronoun *os* or *as* ('them'). The accent ^ should be added, and *l* affixed to the front of the pronoun.

There is no data given for 13 of the 47 learners; some did not complete the homework, and in a few copies this part was unreadable, thus these cases were not recorded. This leaves us with 34 example attempts:

S1	Quero ver-lhes	S24	Quero ver-lhes
S2	Quereria-lhes ver	S25	Eu deseo ver-lhas
S3	Quero de ver-lhes	S26	Gostaria de ver-lhos
S4	Quero vê-les	S27	Quero vê-los
S5	Quero ver-lhes	S28	Quero ver-los
S6	Quero vê-los	S29	Quero ve-los
S8	Quero ver-los	S30	Quero vê-las
S9	Querei ver-lhes	S33	Quero vê-los
S10	Quero vê-los	S35	Quero ver-los
S12	Quero vê-los	S38	Quero vê-los
S13	Quero ver-lhes	S39	Quero ver-lhes
S14	Quero ver-lhes	S41	Quero ver-los
S15	Quero vê-los	S42	Quero vê-las
S16	Eu quero vê-los	S43	Quero vê-los
S17	Quero vêr-las	S44	Quero vê-los
S18	Quero ver-lhes	S45	Quero ver-lhes
S20	Quero verlhes	S46	Quero as ver

Errors in the verb form provided for *querer* are ignored here, and inclusion of the subject pronoun *eu* ('I') is considered correct. Of the 34 students, only 12 produced the target form correctly. Only 19 learners used the correct DO pronoun; 18 of these used *los* or *las*, and one, *as*, as this pronoun was incorrectly placed

before the verb, where the *l* would not be required. 12 students used the IO pronoun *lhes*, of these, 10 wrote **ver-lhes*. Two students used the combined pronoun, *lhos* and *lhas* (**ver-lhos/lhas*).

Four of the 19 learners using a correct pronoun wrote **ver-los*; they affixed the *l*, but did not modify the verb. One learner wrote **vêr-las* (i.e. added the *l* and accent, but did not remove the *r*), and one learner wrote **ve-los* (i.e. added the *l* and removed the *r*, but did not add the accent). One student joined the (incorrect) pronoun directly onto the end of the verb (**verlhes*). One student associated the (incorrect) pronoun with the wrong verb, and one used a non-existent form of the pronoun (**les*). There were 2 cases of incorrect placement of the pronoun.

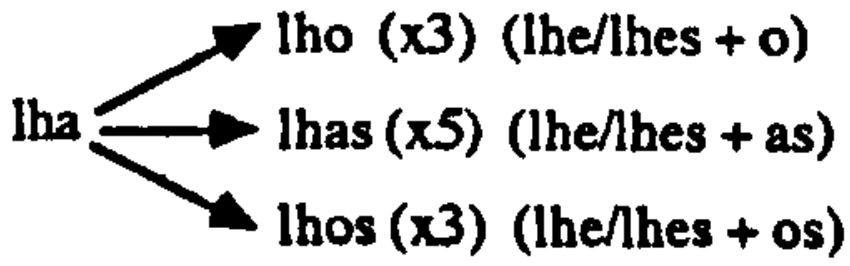
This data correlates for the most part with expectations from the error frequencies depicted in figure 4.1; IOs used in place of DOs are very common, as is non-omission of verb final *r* before the third person DO pronoun. Omission of accents is also extremely common. (Omission of accent is also counted in cases where the final *r* has not been removed. Therefore, as can be seen from the data, the large majority of this error type co-occurs with non-removal of *r*.)

Potential errors which were not apparent in the data, but which might have been expected in this environment given the information in figure 4.1 were: missing *l*, wrong accent and missing hyphen. (The wrong type of DO was less likely for this sentence because both masculine and feminine forms were acceptable translations.) The fact that hyphens were not omitted is probably due to the tendency for this error to occur to a greater extent in the earlier exercises. This exercise was in the final homework on pronouns, given to students.

The non-appearance of missing *l* and wrong accents probably reflects the fact that this exercise immediately followed a sentence transformation exercise designed specifically to practise phonetic contractions. Given the shortness of the sentence, and the fact that the exercise in which it was found followed one devoted to phonetic contractions in the same homework assignment, and learners were therefore probably more aware of the difficulties at that time, the range of errors displayed is surprising. Although there are many identical incorrect translations, there are also a variety of problems revealed. Those errors which may have been expected, but were not evident in the example sentence above, could, of course, be

found in other environments. As an illustration, consider the following target sentence: *traduzi-las-ão* (they will translate them). This is the example given previously for the omission of *l*. Three learners had difficulty with this particular sentence; S5 and S9 writing **traduzê-as-ão*, and S18 wrote **traduzer-as-ão*. (Note that for these attempts the wrong ending has been given to the verb. However, in the first two cases the accent appropriate to the *e* has been added, but the *l* was still not supplied.) Two further sentences: *bebê-lo-ão* (they will drink it), and *comê-los-ão* (they will eat them) will be used to demonstrate examples of use of the wrong accent. S46 wrote **bebé-lo-ão* and **comé-los-ão*, substituting *é* for *ê*. S35 and S41 also wrote **bebé-lo-ão*, but wrote *comê-los-ão* correctly. The reverse was true for S26, who produced the correct accent for *bebê-lo-ão* (but an incorrect verb ending: **bebê-lo-eis*), but the wrong accent on **comé-los-eis*.

Further details of the error types of each individual are given in appendix D. In some cases the errors are quite regular, for example, in *IO for DO* each of the 27 errors produced remained faithful to number; i.e. *los* became *lhes* and not *lhe*. This was the case for several error types. However, some categories are less straightforward, such as the *within type combined form* exchanges. Looking at *lha* (lhe/lhes + a), 3 different errors were made:



In the first case of *lho* the learners have retained the number, but changed the gender. With *lhas* students have retained the correct gender, but made the singular into plural. Finally, with *lhos* learners have changed both number and gender.

4.1.2 Use of the Empirical Data in Mr. Collins

As described above, actual student errors in the target domain of object pronoun use in European Portuguese have been researched to enable the system to identify probable misconceptions while at the same time avoiding the anticipation or description of unlikely errors. As occurs in other domains, it has been discovered that what appear to be incompatible error combinations can occur, and a means of representing this possibility in the system is therefore essential. Mr. Collins also uses

knowledge of the relative frequency of different errors, e.g. in the above example of non-omission of verb-final *r*, *s* or *z*, nearly all students will fail to provide the additional accent. Most will however remember to add the *l* to the pronoun, though a still significant proportion will not do this. A small percentage will sometimes add the *l*, and sometimes forget it. Until the system has obtained sufficient input to determine a particular learner's usual preference (if he has one), these error types will be sought in the order presented above (for greater computational efficiency).

There is a distinct lack of predictability for error types; i.e. the existence of one type of error does not necessarily exclude another type from being made by the same student, even in cases where the two errors appear contradictory. The following example of phonetic contractions with pronouns illustrates this point.

The most common type of error observed amongst students who did not remove the final *r*, *s* or *z* before a third person direct object pronoun was the omission of the accent. This occurred most often in combination with correct addition of the *l*, though in about one third of cases the *l* was also omitted. It might be expected that in combination with the omission of the accent, a student would consistently either remember to add the *l*, or never do so (at least within one exercise). This type of behaviour would make assessment by the system easier, as the same combinations for each student could always be checked. Although this is indeed usually the case, i.e. most students committing final letter errors add the *l* but omit the accent, and another group omit both components, in one (sentence transformation) exercise four students sometimes added the *l* and sometimes did not. Therefore, although as a general rule the system can look for certain groupings of errors, it cannot assume that a student will always be consistent.

A second example, similar to that described above, is the case of missing accents vs accents provided in inappropriate contexts (e.g. in *unstressed* final syllables) vs the wrong type of accent (e.g. *é* instead of *ê*). It could be hypothesized that a learner who often omits the accent will not provide the wrong accent or provide an accent in an inappropriate context, because in general he tends to not use these in obligatory contexts. However, this is not necessarily the case! 12 of the 47 students sometimes miss out the accent, while a near equal number (13) provide an accent in an inappropriate environment. 5 students provided examples of the wrong type of accent. For individual learners there were 6 co-

occurrences of missing accent + accent in inappropriate context; about half the cases of missing and inappropriately produced accents therefore occurred in the same students. There were 3 combinations of missing and wrong accent types (and 2 cases of inappropriately provided and wrong type of accent - this latter combination of error types cannot be regarded as incompatible). It can be seen from this that the student model of the ICALL system must allow the existence of such incompatibilities. Figure 4.4 shows a student (S26) who made each of the three possible accent related errors (one other student also committed each of the possible accent error types).

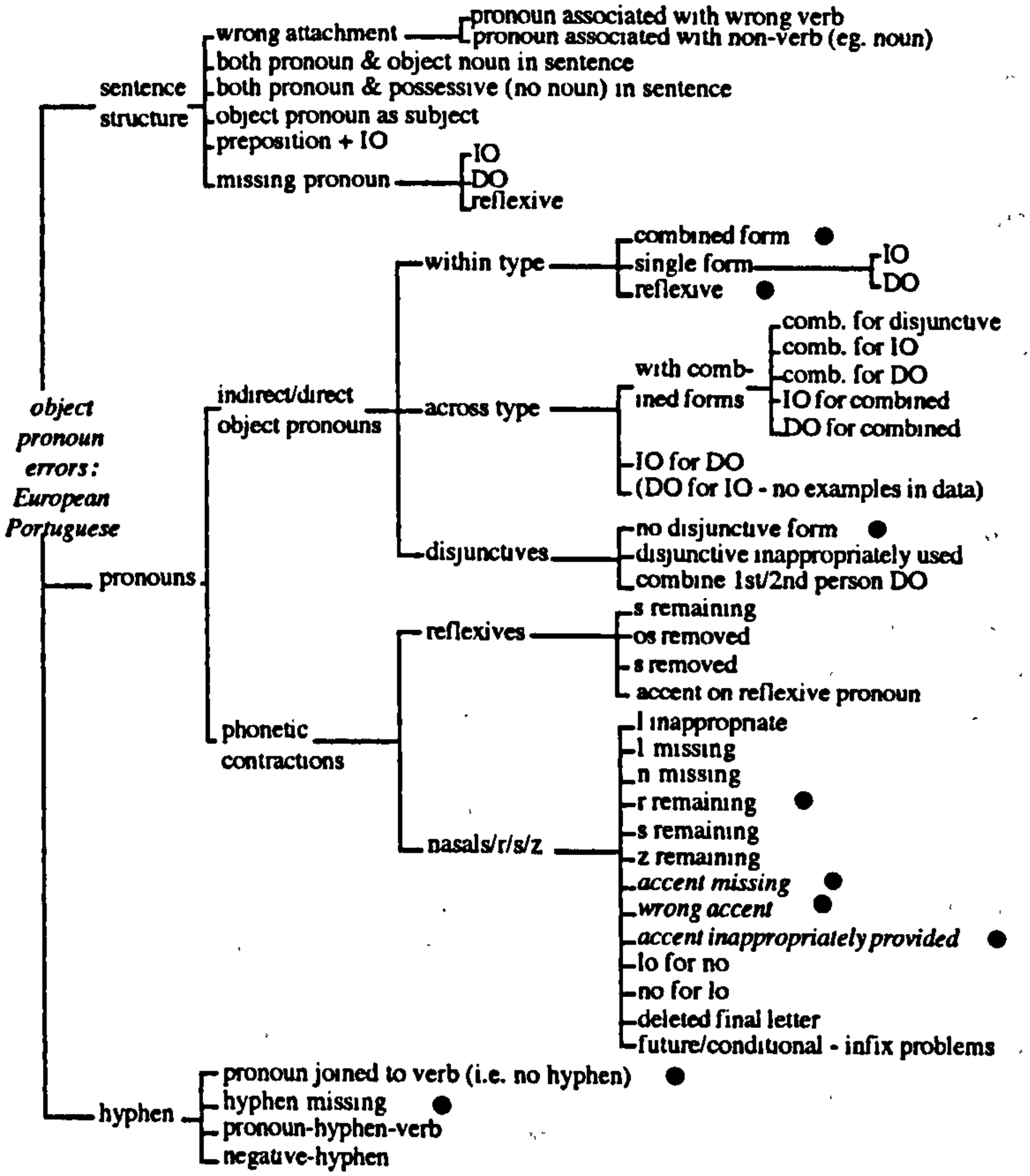


Figure 4.4: error types of S26

As stated previously, errors of omission of *r*, *s* or *z* in combination with the presence and absence of the *l* and accent, are very common. From the data in appendix D concerning these errors it is possible to construct the following diagram (figure 4.5), to illustrate the relative frequency of the various combinations. (The greater the number, the more frequent the error - i.e. '17' = 17 errors.)

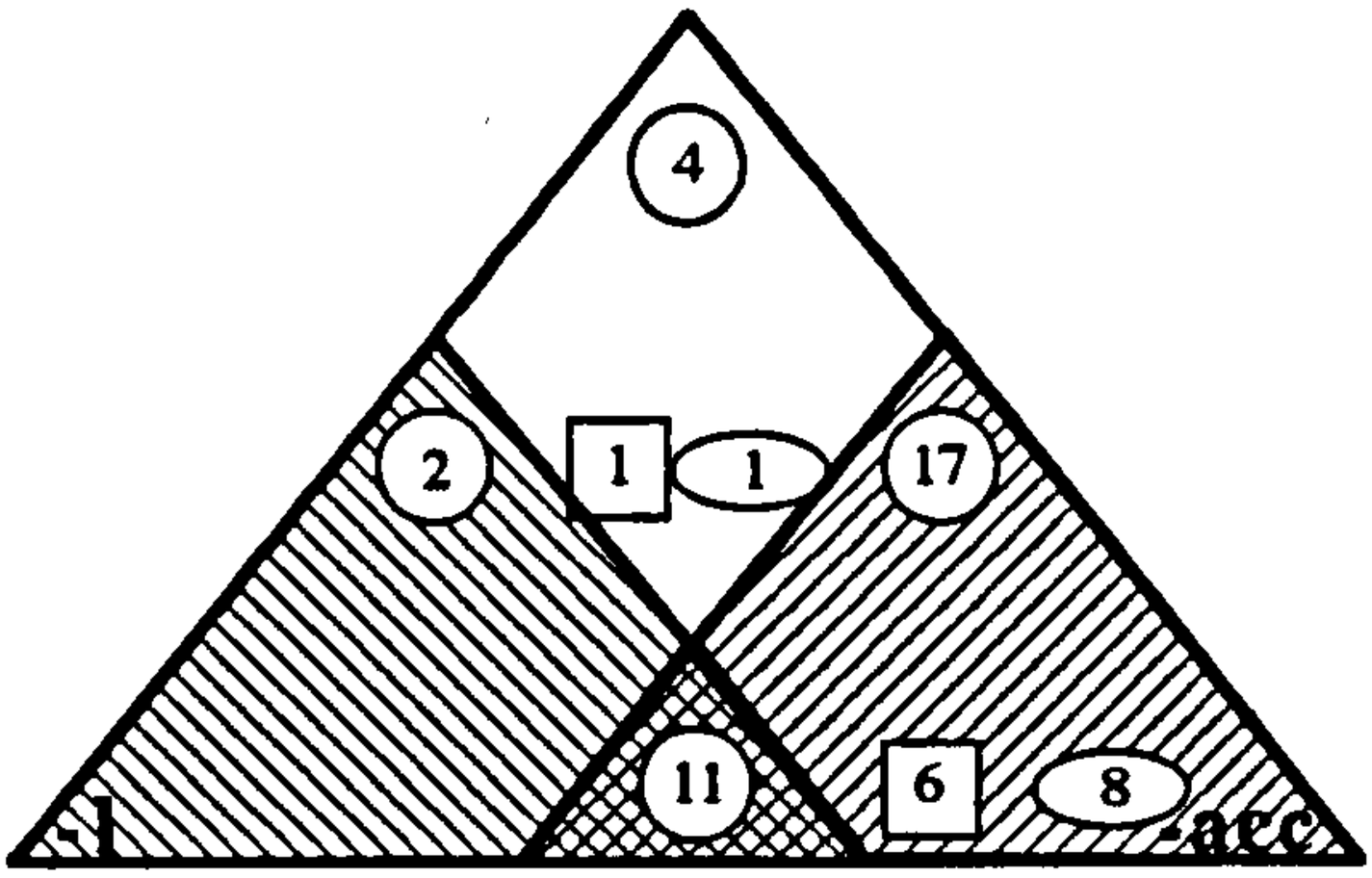


Figure 4.5: combinations of *r*, *s* or *z* remaining / presence or absence of *l* and accent / pronoun type

Key:

DO pronoun (correct)

IO pronoun (incorrect)

combined form pronoun (incorrect)

The left hand side of the triangle represents attempts at phonetic contractions where the *l* has been omitted (-l). The right hand side indicates cases where the accent should be added, but is missing. The overlap of these two triangles represents cases where both *l* and the accent are absent. The unshaded area above is for phonetic contractions where the *r*, *s* or *z* remain, but any other contractions required have been effected.

The closer to the top of the diagram that a number appears, the more accurate the phonetic contraction is (in terms of the number of correct components).

(4) (*r*, *s* or *z* remaining = +rsz) has only one problem: the persistance of the final letter (e.g. **Quero vêr-los*).

(2) [1] (I) (17) have 2 incorrect elements:

(2) = +rsz -l;

[1] = +rsz +comb;

(I) = +rsz +IO;

(17) = +rsz -acc.

(11) [6] (8) are each a combination of 3 errors:

(11) = +rsz -l -acc;

[6] = +rsz -acc +comb;

(8) = +rsz -acc +IO.

Due to its higher number, (17) is the most common combination from this group (in terms of frequency of occurance rather than number of students). This is in the middle range - i.e. it is not one of the most, nor least correct phonetic contractions. The three least frequent error combinations are also in this range. From this information Mr. Collins is able to follow the most efficient sequence in which to seek these problems:

+rsz -acc --> +rsz -l -acc --> +rsz -acc +IO --> +rsz -acc +comb -->
+rsz --> +rsz -l --> +rsz +IO / +rsz +comb.

i.e. the above is the order in which the error combinations are stored in the computational grammar, and therefore the order in which they are sought. Thus, in the context of our *quero vê-los* example, for an incorrect sentence entered by the user, when checking for erroneous phonetic contractions the system first tries to

match the learner's input to **quero ver-los* (as this can be generated from the first case above: +rsz -acc; the *r* remains but the accent is missing). If no match is found, the system proceeds to check for **quero ver-os* (from +rsz -l -acc), and so on.

Errors involving hyphens observed amongst students (in order of frequency) are:

omission of hyphen;
joining a pre-verbal pronoun to the verb with a hyphen;
pronoun affixed directly onto the end of the verb (i.e. no hyphen);
pronoun joined to a non-verb by a hyphen (e.g. attached after negative or noun).

As with phonetic contractions, knowledge of the relative frequency of these errors allows the system to parse incorrect input more efficiently where there is as yet no relevant information in the student model (i.e. frequently occurring errors are checked for first). Again, as with the case of accents described above, apparently contradictory errors can occur with hyphens. Three students, despite sometimes omitting an obligatory hyphen, sometimes also provided one where it was not required. For each of them this occured in two different inappropriate environments.

In general, where there is no specific individualised information in the student model, common error combinations, and those errors indicated as most frequent in figure 4.1 are checked for first, followed by the second most frequent error types, and so on.

4.1.3 Evaluation of Error Handling in Mr. Collins

Section 2.1 called for the need for authors to either consider research results on the types of problems students experience with the target domain of an ICALL system, and the reasons for these difficulties, or to carry out their own empirical research before designing the system. Section 4.1 has illustrated the results of such an empirical study conducted to inform the design of the Mr. Collins student model. Not all the error types identified are handled in the system, for example, none of those in the category of sentence structure can be dealt with. The error analysis has

allowed the selection of useful areas to demonstrate the system aims. Mr. Collins has focused on pronoun placement (see section 4.4), problems with hyphens, and phonetic contractions (nasals/r/s/z). Thus the following are typical exercise sentences in the system[6], where correct attempts and errors can be recognised and accounted for:

PRONOUN PLACEMENT

pre-verbal:

Não lhes disse nada.	(He did not tell them anything.)
Francisco nunca admitua que a amava.	(Francisco never admitted he loved her.)

post-verbal:

O Manuel trouxe-te o artugo?	(Did Manuel bring you the article?)
Este livro explica-o.	(This book explains it.)

between auxiliary and past participle:

Tenho-os visto	(I have seen them.)

infix

Vendê-los-ão.	(They will sell them.)
Neste caso vendê-la-ia.	(In that case I would sell it.)

PROBLEMS WITH HYPHENS

Este livro explica-o.	(This book explains it.)
Não lhes disse nada.	(He did not tell them anything.)

PHONETIC CONTRACTIONS

Vendê-los-ão.	(They will sell them.)
Quer estacioná-lo aqui.	(He wants to park it here.)
Empurraram-na.	(They pushed it.)

6 Thanks are due to Wamberto Vasconcelos, Antonio Ribeiro and Ana Paiva for providing some of the sentences in the system.

Pronoun placement is dealt with in a more comprehensive manner in section 4.3. Here just one example of possible placement difficulties will be given, for the sake of clarity. In the sentence *Este livro explica-o*, the most likely placement error is **Este livro o explica*(assuming students realise that the pronoun must always be associated with the verb). Mr. Collins can recognise this error as potentially being a case of overgeneralisation from another Portuguese rule, or transfer from another language, by 'borrowing' rules from other sentence types and rules from the same type of sentence from a different language, and comparing the results of parsing the student's input with these rules, to parsing with the expert rule. Mr. Collins does not currently recognise errors in other positions, as these belong to the category of sentence structure which is not dealt with in the system.

The most common hyphen error is simple hyphen omission, e.g. **Este livro explica o*. Mr. Collins deals with this through its recognition of 'non-hyphen'. There is also a rule to detect the joining of a verb and pronoun into one word, as in **explicao*, where the two components must be decomposed. Mr. Collins can also detect when a correctly placed pronoun is associated with a non-verb as in **Não-lhes disse nada* and attached in front of the verb as in **Não lhes-disse nada*, through 'misplaced hyphen' heuristics.

As seen previously, there are a wide variety of possible errors in phonetic contractions. Because many of these are easily predicted given the data, Mr. Collins can recognise various error types with phonetic contractions by a set of rules which recombine the various rules in different groupings. For example, in the sentences given above: *Vendê-los-ão*, *Quer estacioná-lo aqui* and *Empurraram-na*, Mr. Collins checks for wrong or missing accents, omission of *l* or *n*, non omission of *r*, omission of *m*, etc., and combinations of these difficulties.

The relative frequencies of particular errors and error combinations are known by the system, to enable it to perform its parsing as efficiently as possible.

The manner in which Mr. Collins actually locates errors through parsing students' sentences is not discussed in detail here, as a very simple parsing mechanism is used. This is almost certainly not the best approach, but for our small domain it is adequate, and as the aim of the thesis is not concerned with

natural language processing (by computer), the parsing approach used is irrelevant as long as it supports the goals of the system. The approach used is that of a definite clause grammar with appropriate mal-rules as identified from the empirical data collected in study 1. A better parsing approach could be substituted in a future system; the important point here is that for sentences which are syntactically incorrect, the parser is used in a manner which is able to indicate the most likely cause(s) of difficulty, and then use this information in a meaningful way. This is described further in section 4.3.3, and the notion is extended in section 4.5. A full example of parsing by the system is given in chapter 5.

Some exercises used in Mr. Collins take the form of sentences offered to the student, with the object pronoun missing. The desired pronoun is provided separately, and students must place this into the correct position in the sentence by editing the sentence (see figure 4.6).

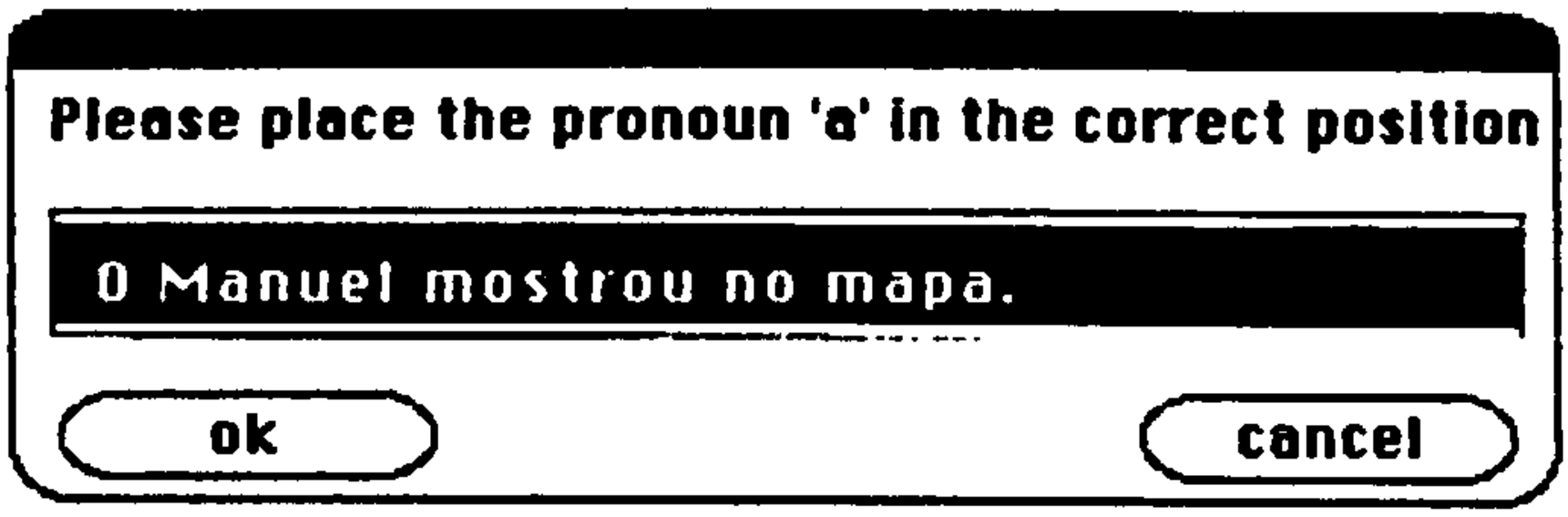


Figure 4.6: example exercise sentence

This is a positive main clause sentence, therefore the pronoun should follow the verb. Thus the correct response is: *O Manuel mostrou-a no mapa.* (Manuel indicated it on the map.) This sentence requires no phonetic contractions, but the learner must remember to include the hyphen. (A more complicated sentence would be the example we have seen before: *Quero vê-los*, where the *r* of *ver* must be dropped, the accent added, and *l* prefixed to the pronoun. The hyphen is also required.)

Other exercises involve translation from English to Portuguese[7]. The vocabulary is provided, as the system is not equipped to deal with a range of errors beyond pronoun use. (This is beyond the scope of the research intended.)

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7 Some of the translation exercises were implemented by Matt Smith.

An important point raised in Section 2.1 was the fact that error analysis should form only one part of the overall approach of the system. The system can also question the student directly about his beliefs, and follow the more usual processes of infering likely causes of difficulties from the information already contained in the individualised component of the student model. It may also refer to other languages known by students, if these may be affecting their Portuguese, or look at the route learners typically follow when learning the given rules. These are all complementary approaches. They will be examined in turn in the following sections.

4.2 Language Transfer

In section 2.2.3 it was claimed that learners' background languages (i.e. native and other foreign languages) should be taken into account as potential sources of transfer. It was shown in section 2.2.2 that designers of systems dealing with transfer tend only to consider learners' native languages as relevant. This is possibly due to the small amount of literature pertaining to non-native transfer. However, that literature which is available indicates that non-native transfer exists in at least some settings, and the possibility of non-native transfer should therefore be considered when designing ICALL systems to handle transfer. Mr. Collins is an early attempt at addressing this question.

4.2.1 Language Transfer in Mr. Collins: which languages?

Before discussing why certain languages were selected for representation in Mr. Collins, it is useful to demonstrate the possibilities for transfer in the domain of this system. The following illustrates three of the rules for personal object pronoun placement in several European languages (in 1. affirmative clauses; 2. negative clauses; 3. with the auxiliary and past participle):

Portuguese

1. verb, pronoun.	e.g. Compra-os.
2. neg, pronoun, verb.	e.g. Não os compra.
3. aux, pronoun, verb.	e.g. Tem-nos comprado.

English

1. verb, pronoun. e.g. He buys them.
2. neg, verb, pronoun. e.g. He does not buy them.
3. aux, verb, pronoun. e.g. He has bought them.

Spanish

1. pronoun, verb. e.g. Los compra.
2. neg, pronoun, verb. e.g. No los compra.
3. pronoun, aux, verb. e.g. Los ha comprado.

Italian

1. pronoun, verb. e.g. Li compra.
2. neg, pronoun, verb. e.g. Non li compra.
3. pronoun, aux, verb. e.g. Li ha comprati.

French

1. pronoun, verb. e.g. Il les achète.
2. neg1, pronoun, verb, neg2. e.g. Il ne les achète pas.
3. pronoun, aux, verb. e.g. Il les a acheté.

German

1. verb, pronoun. e.g. Er kauft sie.
2. verb, pronoun, neg. e.g. Er kauft sie nicht.
3. aux, pronoun, verb. e.g. Er hat sie gekauft.

The rule applicable for the position of pronouns in affirmative statements in Portuguese dictates that the pronoun should follow the verb (rule 1). The same is true in English and German; however Spanish, Italian and French differ, requiring the pronoun to be pre-verbal. In negative sentences (rule 2), the rules for pronoun placement are similar in Portuguese, Spanish, Italian and French, but different in English and German. In the perfect tense (rule 3), The Portuguese rule is similar to the equivalent German rule, but differs from the other languages. In Portuguese the pronoun is placed between the auxiliary and past participle, while English places it in final position, after the past participle. In Spanish, Italian and French the pronoun occurs before the auxiliary. From these three examples it can be seen that

errors of pronoun placement, although possibly a result of overgeneralisation of other Portuguese rules, may instead be based on analogy with another language. Moreover, the fact that transfer from a particular language may be useful in one case does not imply that this will be useful in general (and vice versa).

It was stated in section 2.2.3 that a survey of target users' language backgrounds should be undertaken, to determine possible candidate languages for inclusion in a language learning system dealing with the issue of language transfer. Such a survey (study 2) was conducted by the author, the results of which are presented below.

STUDY 2

A questionnaire study involving 20 undergraduate, beginning students of Portuguese was undertaken. Students were asked about languages known, their proficiency in these languages and whether they consciously compared Portuguese to any of these other languages. (This excludes the possibility of considering non-conscious comparison, though it has been assumed that where this occurs, it may take place in similar circumstances.) The results are as follows:

Every student of Portuguese who also knew *Spanish* (15 in total), compared Portuguese with Spanish (all students were either advanced or near fluent in Spanish[8]).

Only two students compared to *English*. One knew no Spanish, and perhaps for this reason looked to English, and the other compared to all languages known (English, Spanish and French). All members of the group were native/near fluent speakers of English.

Nearly twice as many learners compared to *French* as not; the tendency was for comparison to occur from advanced level upwards. All three non-Spanish speakers who knew French compared Portuguese to French (possibly because this was the most similar alternative).

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8 It would of course be interesting to see the extent of reference to Spanish by speakers of lower proficiency in this language.

No-one transfered from *German*, despite a high level of knowledge of this language by all German speakers. (This was probably due to the relative dissimilarity of Portuguese and German.)

No conscious reference was made to those few other languages not closely related to Portuguese[9]: *Danish*, *Polish*, *Dutch*, *Irish* and *Ancient Greek*. Apart from the Danish speaker, speakers of these languages had a low level of proficiency. (The Danish speaker compared Portuguese to both Spanish and French, and maybe for this reason did not compare with the more distant Danish.) One learner compared Portuguese with *Japanese* (in which he was a beginner). This last example does not fit the pattern of similarity and proficiency leading to transfer.

It was not possible to observe a pattern for *Italian* (possibly because of the low level of proficiency of speakers of this language.)

From these results it can be seen that Spanish and French were the languages most frequently involved in comparison with Portuguese, for these beginners in Portuguese who were (mostly) native English speakers at university level.

The above results also indicate a tendency for similarity of, and proficiency in a background language to lead to comparison (and probably transfer). Proficiency alone is not sufficient (see English/German), and similarity alone is also not sufficient (see French/Italian). Proficiency + Similarity is a much better predictor (though this is not infallible). Only 11 out of 73 possible cases do not fit the pattern of proficiency + similarity leading to transfer:

i. 4 of these 11 cases fulfil similarity + proficiency, but do not result in (conscious) comparison.
ii. 2 of these 11 cases fulfil only proficiency, but comparison is reported despite dissimilarity.
iii. 4 of these 11 cases fulfil only similarity, but comparison is reported despite low proficiency.
iv. 1 of these 11 cases is comparison with a dissimilar language known only at a basic level.

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9 The author's judgement of closeness.

Of the 11 exceptions of the assumed case of proficiency + similarity leading to transfer, 6 meet one half of the requirements. Only 5 (under 7% of total: i & iv above) seem completely atypical. These results match those expected; research suggests that higher proficiency in a background language may lead to a greater extent of transfer (see Ringbom, 1983), and Kellerman (1977) states that learners tend to transfer more from languages which they perceive to resemble the target language than from those they consider more distant.

STUDY 3

We will now review Benson's (1989) results[10] (presented in section 2.2.1) based on a separate, but similar study carried out by the author. This second study was based on 47 undergraduates' completion of four mixed pronoun placement exercises spread across five weeks (multiple choice, translation and sentence transformation tasks - see section 4.1.1)[11]. These students were all beginners in Portuguese. Nearly all learners involved were native speakers of English; the few exceptions had a high degree of fluency in English. Not all learners knew Spanish, however a large majority had some knowledge. Because this study was larger than that of Benson (i.e. more students + greater number of questions per student), and there were more opportunities for students to make errors, there were only two students out of the 47 who exhibited no difficulties at all with pronoun placement. Sixteen learners made placement errors fairly equally in Portuguese rules coinciding with those of either English or Spanish. Seventeen tended to complete sentences correctly in cases where the Portuguese and Spanish rules are identical, and made more errors in sentences where English coincides with Portuguese, but Spanish does not. For nine students the reverse was true (i.e. they generally performed better in sentences where English resembles Portuguese). In three cases it was not possible to determine the source of an error, as these were all confined to sentences in which the Spanish and English rules are identical.

This overall result clearly matches that noted by Benson - i.e. with many students *L_2 Spanish may have more influence on the acquisition of this aspect of Portuguese than L_1 English.* This is even more striking when it is remembered that

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10 Recall that Benson found Spanish to be more commonly a source of transfer than English, for her native English speakers.

11 These were the same subjects as in study 1.

several of the learners in this study did not know Spanish, and thus biased the results towards English. However, this possibility is not intended as a claim, but is speculation: errors and correct sentences may also be the result of some other phenomenon (e.g. inappropriate or successful overgeneralisation of other Portuguese rules, or acquisition of the target rule). Nevertheless, it is likely that some of the recorded cases were actually due to positive or negative transfer.

The results of these two studies indicate that models of the equivalent rules of Spanish and French should be included in the system, hence the choice of these languages for Mr. Collins. English is the native language of most of the 47 students whose language production was studied in order to provide information for the construction of the system and, as seen above, about one fifth of these students may have been influenced primarily by English in cases of transfer. As these students are considered typical of undergraduate learners of Portuguese in Britain, English was therefore also an obvious choice for inclusion in Mr. Collins. Catalan is also represented in Mr. Collins, as the rules for pronoun placement are identical to the Spanish rules. This will enable more effective evaluation of the system if it can be tested with bilingual Spanish/Catalan students, as the rules of both native languages coincide, and due to their relative similarity to Portuguese these languages are strong candidates as potential sources of transfer.

It is not necessarily an easy task for a system (or a teacher, for that matter) to determine which of a learner's background languages is the most probable cause of a transfer error; a learner who knows both Spanish and French, for example, could be comparing (consciously or not) with either of these languages when placing the pronoun pre-verbally in affirmative main clauses. This section has demonstrated that taken together, proficiency in a background language and perceived language distance can be used to predict the source of transfer quite accurately. Therefore these two issues are taken into account when the system is trying to locate the source of an error, or seeking to suggest a good source for positive transfer.

The results presented in this section also offer further support to the (sparse) literature on non-native language transfer, for the claim for a need to consider students' other languages when trying to model their learning of a new foreign language. The following sections describe the manner in which Mr. Collins handles transfer from multiple background languages.

4.2.2 Obtaining Initial Information: the Learner Profile

The basic information regarding a learner's language background is obtained at the start of a student's first interaction with the system. During this initial interaction, a learner profile is constructed which can be consulted and updated during future sessions. The learner profile is composed in the following manner: the student is offered a menu from which he is requested to identify his native language(s). There follows a second menu requesting the selection of other languages known. As stated above, because transfer may potentially occur from any of these languages, it is essential that the system is able to identify the correct source of a transfer error (i.e. it must attribute any difficulty to the correct base language). Therefore further information about the learner's background languages is obtained.

The two factors identified from the first study described in section 4.2.1 are considered here; firstly, a learner's *proficiency* in each of his background languages. (Recall that Ringbom (1983) suggests proficiency to be a determinant affecting the extent of transfer; a student is more likely to transfer from a language in which he has a higher degree of fluency.) The learner is therefore asked to indicate his proficiency in the foreign languages concerned, on a five point scale: (near) fluent, advanced, intermediate, patchy, beginner. Secondly the student is requested to state his assessment of the *language distance* between each of the languages he knows and the target Portuguese, i.e. his perception of the degree of similarity between these languages. (Kellerman (1977) states that languages perceived to resemble the target are more likely to be sources of transfer.) Figure 4.7 shows the type of information available about a learner who has completed the learner profile. This example is for a learner who knows Spanish and English.

NATIVE LANGUAGE: Spanish

You stated that you consider Spanish to be SIMILAR to your target language. You are VERY LIKELY to transfer from Spanish.

OTHER LANGUAGE: English

You stated that you consider English to be DISSIMILAR to your target language, and that your proficiency in English is ADVANCED. These two factors considered together indicate that you MAY SOMETIMES transfer from English.

The order in which you are most likely to rely on your background languages is as follows:

Spanish, English.

Figure 4.7: example of transfer information deduced from the learner profile

A learner may also view and compare the target Portuguese rules with the equivalent rules and examples of other languages known. Thus, our English/Spanish speaker may obtain information on rules as depicted in figure 4.8.

The pronoun is post-verbal in affirmative main clauses in:	The pronoun is pre-verbal in affirmative main clauses in:
Portuguese	*Spanish*
e.g. Compra-os	e.g. Los compra
English	
e.g. He buys them	

Figure 4.8: comparison of languages

The availability of this general and individual information at this early stage is designed to prompt the learner into thinking about the positive and negative aspects of language transfer. More detailed information about a learner's actual use of transfer cannot be provided until the interaction is further advanced. This will be discussed in the next section.

4.2.3 Identifying the Source of Transfer

The two issues of proficiency and perception of language distance are considered together when the system is trying to identify the cause of transfer-related difficulties, or seeking to prompt positive transfer: the various native and foreign language parsers are ordered according to a principle of 'most proficient and most similarly perceived language first' i.e. the system considers the most likely sources of transfer first. As an example, imagine a native English speaker provides the information to the initial learner profile that he feels Portuguese and English to be quite distant from each other. He then informs the system that he knows Spanish to a high degree of fluency, and perceives Spanish and Portuguese as similar languages. In such a case, in later interactions the system would look for evidence of transfer from Spanish before checking English - the similarity factor here overrides the dominance of transfer from the L_1, as the learner's ability in the similar L_2 is above a certain threshold. (Of course, if later interactions were to demonstrate that for this learner English had greater influence, the system would adapt its strategy accordingly.) As French and Catalan are not known, these languages would be excluded from participation in all interactions in this example.

Figure 4.9 below illustrates the calculations currently used in the system for deciding which of a learner's languages is the most likely source of transfer. For example, a native language, as declared by the student during the construction of the learner profile, is classified (by the system) as 'highly' fluent, and the student will decide whether they consider this language to be similar to the target Portuguese. A native language given the value 'similar' will be assigned the parse number '1' by the system. A native language felt to be quite distant from the target will be assigned the parse number '4'. A (near) fluent non-native language which is considered similar to the target receives the parse number '2', while a (near) fluent non-native language which is felt to be quite distant from the target language is assigned the parse number '5', etc. When checking the source of transfer from the languages applicable in the context, that language with the lowest parse number is identified as the source (unless the student himself offers explicit alternative evidence, or unless the previous interactions have demonstrated that the learner tends to transfer more from a language with a higher parse number). Similarly, should the system wish to prompt positive transfer, it will choose the appropriate language with the lowest number with which to compare Portuguese (again, unless

there exists alternative evidence to suggest a more appropriate language). It is possible that two languages can be assigned equal numbers. In such cases these are simply checked in the order in which they are encountered.

language	*fluency*	*similarity*	*parse number*
native language	highly fluent	similar	1
non-native language	(near) fluent	similar	2
non-native language	advanced	similar	3
native language	highly fluent	dissimilar	4
non-native language	(near) fluent	dissimilar	5
non-native language	intermediate	similar	6
non-native language	advanced	dissimilar	7
non-native language	patchy	similar	8
non-native language	intermediate	dissimilar	9
non-native language	beginner	similar	10
non-native language	patchy	dissimilar	11
non-native language	beginner	dissimilar	12

Figure 4.9: identifying the source of transfer

This combination of proficiency and perceived language distance is currently somewhat arbitrary; further testing of the system in use would be required to determine the most effective ordering for proficiency versus perceived similarity.

As learners' use of transfer is traced and identified by the system, this information is also available to the students. Examples of the type of transfer information available to an individual include:

1. an explanation of which of a learner's languages is most likely to be the source of transfer;
2. a description of the sentences in which transfer has appeared, together with the language from which transfer occurred in each case;

3. a comparison of sentences in which transfer occurred with sentences where it did not;
4. a statistical summary of the frequency of transfer from each language;
5. a description of likely transfer problems (based on previous performance and learning strategies used);
6. a general description of possible transfer (positive and negative), i.e. explicit comparison of rules of different languages;
7. system suggestions of where a student may improve his performance through the use of positive transfer.

Figure 4.10 below shows an example student/system interaction[12] using some of this information.

---

student (selects from student menu):

transfer »

what language(s) am I most likely to transfer from?

system:

Because **Spanish** is your native language, and you consider Spanish to be SIMILAR to your target language, you are VERYLIKELY to transfer from Spanish.

Because **Catalan** is your native language, and you consider Catalan to be SIMILAR to your target language, you are VERYLIKELY to transfer from Catalan.

You also know **English**. You consider English to be DISSIMILAR to your target language. Your proficiency in English is ADVANCED. These two factors taken together indicate that you MAY SOMETIMES transfer from English.

You also know **French**. You consider French to be SIMILAR to your target language. Your proficiency in French is INTERMEDIATE. These two factors taken together indicate that you are LIKELY to transfer from French.

The order in which you are most likely to refer to your background languages is as follows:

Spanish, Catalan, French, English.

Would you like

- examples of your use of transfer
- a comparison of sentences with and without transfer
- a summary of the frequency of transfer

---

12 Obtained from a test interaction with the system, with the tester behaving as a student might. Most of the system's part of the interaction is presented from pre-stored text.

- a description of likely transfer problems
- a general descrition of possible transfer

student (selects):

examples of my use of transfer

a comparison of sentences with and without transfer

a description of likely transfer problems

system:

1. You have attempted 2 yes/no questions:

   Chama-se João?

   Your attempt: * Se chama João?

   You have probably transferred from Spanish or Catalan.

   The Spanish equivalent is: Se llama João?

   The Catalan equivalent is: Es diu João?

   A carta confirma-o?

   Your attempt: * A carta o confirma?

   You have probably transferred from Spanish or Catalan.

   The Spanish equivalent is: Lo confirma la carta?

   The Catalan equivalent is: Ho confirma la carta?

2. Each of these sentences shows probable transfer.
3. Because you list transfer as one of your learning strategies, and because you do not use the Portuguese focussed strategies of deduction and inferencing, you are especially likely to transfer. As stated earlier, this transfer is most likely to be from Spanish or Catalan due to your fluency in these languages and because you consider Spanish and Catalan to be similar to Portuguese.
4. As you also know English, it would be useful to compare the Portuguese and English rules, as these rules are identical.

   Do you wish to do so?

   - yes
   - no
   - (cancel)

student (selects):

yes

system:

The pronoun is post-verbal in yes/no questions in Portuguese and English.

e.g. Portuguese: Compra-os?

English: Does he buy them?

Figure 4.10: example interaction about language transfer

In this example the student first selects from the student menu to view information about language transfer (this is therefore an example of student initiated interaction). The student then requests information about the languages from which he is most likely to transfer. In this case, the information provided is very similar to the examples given in figure 4.7 from the learner profile, however here the system also has other information available. On this occcasion, for this request there is no other information needed as the student does, in fact, transfer most from the languages cited (see later in figure 4.10 above). The system then offers the student the alternatives available for further interaction about language transfer, and the student selects to see examples of his own use of transfer, a comparison of sentences with and without transfer and a description of likely transfer problems. A summary of frequency of transfer would simply have been a list of sentences and languages identified as the probable source of transfer, with a numerical total of the number of times the student has transferred from each language, and a general description of possible transfer would have been a comparison of rules and examples from different languages - as illustrated in figure 4.8.

In providing examples of the student's use of transfer the system informs the student of how many sentences of a particular type have been attempted, and lists those which exhibit probable transfer. The most likely source languages are identified, and example sentences from these languages are provided[13].

The system has then been requested to offer a comparison of sentences with and without transfer. As there were no instances of sentences not involving transfer, the system simply states that each of the sentences attempted is likely to have been based on transfer. It then describes the student's likely transfer difficulties before trying to prompt consideration of positive transfer from one of the student's other languages.

4.2.4 Advantages of Considering Non-Native Transfer

In order to consider the advantages of this approach, let us return to the case in section 2.2.1, of the native English speaker with a knowledge of Spanish. Imagine

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13 The program currently has examples in the four other languages to illustrate a subset of the Portuguese sentences.

such a learner has entered the following Portuguese sentence into the system: * *O empregado o trouxe.* The correct word order for this sentence would be: *O empregado trouxe-o* ('The employee brought it'). This type of error occurred quite frequently amongst the 47 students whose performance was studied by the author, particularly in the earlier stages of learning. Because Mr. Collins is able to detect possible cases of transfer by using the equivalent rules of other languages in parsing the target Portuguese, it is able to recognise that although this error of pronoun placement may be due to incorrect overgeneralisation of another Portuguese rule, it may instead be due to transfer from L_2 Spanish, as the pronoun would occur pre-verbally in this context in Spanish. (The L_1 English is clearly not involved, as transfer of English word order would have resulted in correct production in Portuguese.) Thus a powerful feature of this system is that in addition to L_1 transfer, *Mr. Collins is able to consider the possibility of transfer from non-native languages* as a potential influence on performance in the target language. However, it is not claimed that transfer will be the only cause of difficulties; therefore the system tries to infer whether this is a likely case of transfer, or more likely to be overgeneralisation (or even guessing) depending on the students's most common misconception in this context. If no such inference is possible, or more than one alternative seems likely, the system asks the student for clarification.

A similar example, but one involving transfer from the L_1 English, and where the system can use the L_2 Spanish positively to help the student, is the following sentence entered by the learner: * *O patrão viu o empregado que trouxe-o.* The correct form of this sentence would be: *O patrão viu o empregado que o trouxe.* ('The boss saw the employee who brought it.') As with the previous example, this error may have occurred as a result of overgeneralisation of another Portuguese rule (probably that applicable in positive main clause statements, e.g. *O empregado trouxe-o*), or it may have been due to transfer from the L_1 English (where the pronoun would also occur in post-verbal position). In addition to challenging the student to investigate the problem himself, or explaining the error by stating explicitly that pronouns are pre-verbal in relative clauses, or offering sufficient examples for the student to infer the rule, a further option is available to Mr. Collins. This is to look at other languages with which the student is familiar and use these as a basis for positive comparison. In this case the learner knows Spanish, so the system may point out that the rule for pronoun placement in relative clauses is identical in Spanish and Portuguese. Thus the system is not only able to detect

errors which may be based on transfer, but it is also equipped to *prompt positive transfer from whichever language is most appropriate* for a particular student, where this would be beneficial as an additional coaching option.

Furthermore, as the system contains this information about a student's background languages and use of transfer, the information is available for student consultation if the learner wishes to investigate the matter; i.e. *the learner is also able to take the initiative* (examples of types of information available were given in section 4.2.3 above.)

4.2.5 Evaluation of Transfer in Mr. Collins

Implementation issues

Although current approaches to ICALL design tend not to consider multiple background languages (if they consider the question of transfer at all), section 2.2.1 showed that from an applied linguistics perspective, this is an important issue. Section 4.2.1 presented the results of a survey to discover the language backgrounds of the target users of Mr. Collins, and hence the languages for consideration. Further investigation revealed those languages which students tend to refer to most in their learning of Portuguese. Section 4.2.3 described how these languages are integrated into the system. As suggested in section 2.2.3, each language included is modelled separately, and therefore an appropriate method has been determined to select between various possible alternative sources of transfer. The selection procedure has been based on Ringbom's (1983) arguments for proficiency in the background language affecting transfer, and Kellerman's (1977) notion of perceived language distance influencing transfer. The study of target users of the system indicated the relevance of these two factors for the domain of the system (section 4.2.1). The manner in which this occurs was described in section 4.2.2. Further research[14] needs to be undertaken in order to verify how best to calculate the parse order (from the parse number). From the implementation of Mr. Collins it can be concluded that, once the most appropriate method is identified, the computational implementation is possible. The current version will be useful *at least* in cases where the parse numbers are not close, as a greater distance between parse numbers will increase the probability that the languages are

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14 See section 4.2.3.

checked in the correct order. As long as the order *is* correct, the distance between parse orders (e.g. 2/7, 2/4) does not matter, as this is used *only* to determine the order in which the rules should be checked.

Section 2.2.3 claimed that, as not all problems will be caused by transfer, interaction involving cross-linguistic influence must be appropriately integrated. This has not been addressed further in section 4.2; the manner in which this is achieved is described fully in section 4.3.3.

Student reactions

Even though it is possible to deal with language transfer in the ICALL environment from a computational perspective, it is not obvious whether students will accept this approach readily. Therefore the learner profile was evaluated with students early in the construction of the system[15]. It was considered worth continuing with the full implementation of this aspect of the system only if (at least some) students were prepared to interact explicitly about language transfer. Sixteen learners were involved in study 4, the evaluation of the learner profile (see section 4.4.6 for more details of the students and study). The aim was to discover the extent to which learners would be interested in interacting on the issues of positive and negative transfer. They were introduced to the system and left to construct the learner profile with the system. There then followed a structured interview where their reactions were sought. All students reported in the post-interaction interview that they considered the system's reference to other languages to be a positive aspect. Except in one case, all stated that they would appreciate explicit reference to cases of both positive and negative transfer (to facilitate acquisition through positive comparison, and to aid explanation of errors where negative transfer has occurred). The one learner who was less keen on receiving information on transfer issues would welcome it only in cases where reference to positive transfer was involved, but not as a method of error explanation describing negative transfer. It can be concluded therefore that students are likely to wish to interact with the system explicitly, about aspects of language transfer. It was also demonstrated that they were able to use the system.

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15 The other part of the evaluation of the learner profile was concerned with determining student reactions to discussion of learning strategies. This is described in section 4.4.6.

4.2.6 Summary

Section 2.2 demonstrated the importance of considering non-native language transfer in addition to native language transfer. In section 4.2, the manner in which Mr. Collins handles both types of transfer was described. Examples of information available for student consultation were provided, and an illustrative example of student/system interaction about transfer in general, and about individual use of transfer, was presented. The main advantage of the approach of Mr. Collins is that it is able to consider and identify the source of transfer, and promote positive transfer, from non-native languages as well as native languages. Students appear, in general, to be in favour of explicit interaction about language transfer.

4.3 Acquisition Order of the Target Rules

In section 2.3 various studies of the order of acquisition of rules were introduced. These tended often to be concerned with aspects of language such as morphology or negation. In terms of Mr. Collins we are concerned with word order in the context of clitic pronoun placement. Although this is a restricted area, it was considered important to discover whether there is a typical acquisition sequence for these rules, because, if so, this could be used to very good effect in helping to resolve some conflicts in student modelling. A good example is the issue of overgeneralisation; the student is more likely to overgeneralise from a rule earlier in the acquisition sequence than the current rule he is attempting, than he is from one later in the sequence. Such knowledge represented in the system can be used when the student model has no specific information for the particular learner, based on previous performance. Thus an empirical study was conducted to determine whether a sequence[16] could be identified. This will be described below.

It was seen in section 2.3 that few language learning systems consider the issue of developmental sequences in their design. Following presentation of the results of the acquisition order study undertaken (study 1), the manner in which the observed acquisition sequence is implemented in Mr. Collins is described, and finally an evaluation of the approach adopted, is given.

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16 By 'sequence' we do not here mean sequence in the sense of a series of discrete items; the ordering may overlap.

4.3.1 Is there a Typical Order of Acquisition of the Rules of Pronoun Placement?

Study 1 described in section 4.1.1 also provided information about the acquisition sequence of the target Portuguese rules of pronoun placement. As the learners in this study were all either native or near fluent speakers of English, many of whom also had a high level of Spanish, the results may not be generalised[17]. Nevertheless it was possible to observe some patterns which at least suggest a possible order of acquisition for the rules of pronoun placement for this type of learner (who is assumed to be typical of most English-speaking, university level learners of Portuguese). The suggested acquisition sequence is at this stage provisional; if further research were to indicate any necessary alterations it would be a simple matter to adjust the sequence in the system. The order of acquisition currently used for the student model continuum (see next section) is as follows:

The pronoun is:

1.	pre-verbal in negative clauses	Não os compra. *He does not buy them.*
	pre-verbal in open questions	Quem os compra? *Who buys them?*
2.	post-verbal in affirmative main clauses	Compra-os. *He buys them.*
	post-verbal with positive imperatives	Compra-os! *Buy them!*
3.	post-verbal with infinitives	Quer comprá-los. *He wants to buy them.*
	pre-verbal in certain adverbial phrases	Também os compra. *He also buys them.*
	pre-verbal in relative clauses	Vejo o homem que os compra. *I see the man who's buying them.*

17 However, there have been suggestions that the native language does not affect the *sequence* of acquisition of developmental features in the target language (refer to section 2.3.1).

4.	pre-verbal in subordinate clauses	Sei porque os compra. *I know why he's buying them.*
	between auxiliary and past participle in main clauses	Tem-nos comprado. *He has bought them.*
5.	post-verbal in yes/no questions	Compra-os? *Is he buying them?*
6.	infix in future tense	Comprá-los-á. *He will buy them.*
	infix in conditional tense	Comprá-los-ia. *He would buy them.*

Note: pronouns from each group will be pre-verbal in combination with negatives.

It can be seen from the above that although for these learners a possible acquisition sequence has been identified for some of the rules, others have not been distinguished within particular stages; e.g. although the positioning of pronouns within negative clauses and open questions is probably acquired before pronoun positioning in other contexts, it was not possible to distinguish the order of acquisition of these two rules from each other - some learners achieved better results with negative constructions first, and others with open questions. Therefore the system represents these rules at the same stage. This acquisition order does not coincide with the order in which these students were taught the rules. Neither does it depend on the actual position of the pronoun in the sentence; i.e. pre-verbal and post-verbal pronoun placement alternate in the sequence, it is not the case that all rules for pre-verbal placement are acquired before those for post-verbal placement of the pronoun, and vice versa. There were a few deviations from the sequence listed above, however, individuals tended on the whole to acquire the rules in an order which does not contradict this sequence.

In the classroom instruction of the students who formed the subjects of study 1, the rules of pronoun placement were not all introduced explicitly as can occur in the ICALL system. Students were told that the position of pronouns depends on the importance of the pronoun in the particular sentence. The significant feature is *emphasis*. Where the pronoun is less important it occurs preverbally, but where it has a more significant role in the sentence, it is postverbal.

> It may thus be said to precede the verb when the principal focus of attention in the clause is neither the verb nor the object pronoun itself; otherwise, it will follow the verb directly.
>
> Frier (1992: 17)

However, many of the rules are also given explicitly in the class grammar notes. Examples were introduced in teaching in the following order:

Week 4	Week 8
subordinate clause	future
affirmative main clause	conditional
negative clause	
open question	
relative clause	
after certain adverbs	

The other contexts (imperatives, infinitives, auxiliary + past participle, yes/no questions) were not taught separately; the issue of emphasis was presumably to be used by students to identify the correct positioning of a pronoun.

Comparing this to the acquisition order identified from students taught the rules in the above sequence, we get, as displayed in table 4.1:

Table 4.1

order acquired	*rule*	*week taught*
1	negative clause	4
1	open question	4
2	affirmative main clause	4
2	positive imperative	-
3	infinitive	-
3	after certain adverbs	4
3	relative clause	4
4	subordinate clause	4
4	auxiliary + past participle	-
5	yes/no question	-
6	future tense	8
6	conditional tense	8

It can be seen that the rules which were taught, were taught in the order in which they were acquired[18]. However, four of the rules were not actually taught. One of these was acquired at the second stage, one at the third, one at the fourth and one at the fifth.

4.3.2 The Student Model Continuum

Having taken steps to identify an acquisition order for the target rules, it is important to incorporate this information into the student model. The student model of the ICALL system is therefore not concerned only with the learner's current state, but also traces an individual's developmental sequence (his learning history), and future performance is anticipated based both on this previous performance and also the typical acquisition order of rules. Thus the student model is a *continuum*, as depicted in figure 4.11 below:

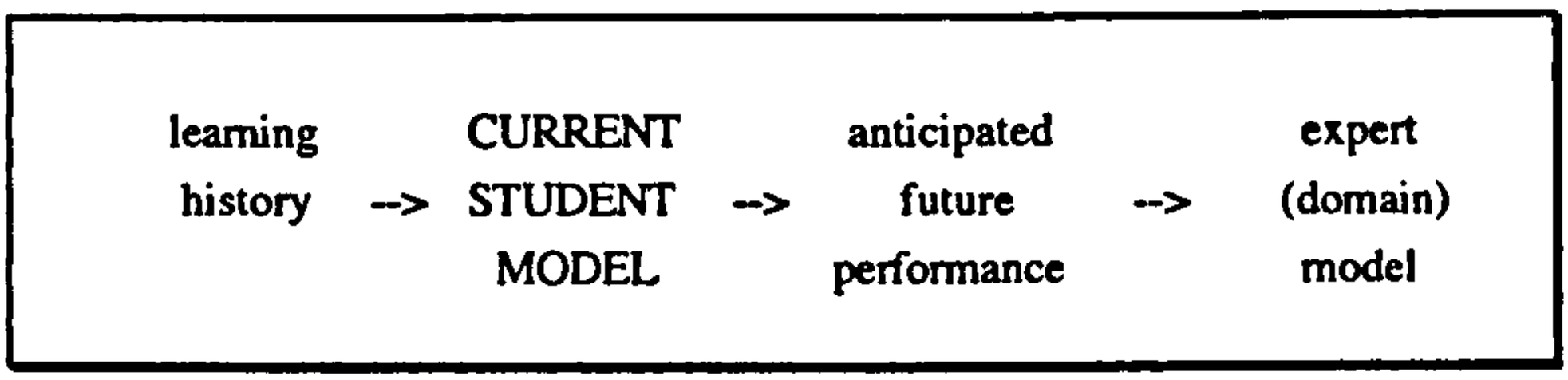

Figure 4.11: The Student Model Continuum I

The acquisition order of the target knowledge is represented in the form of a sequence of student models (as represented in figure 4.12).

18 Possibly because they were taught in two sessions only; the rules in the later session being considerably more complicated than those taught earlier.

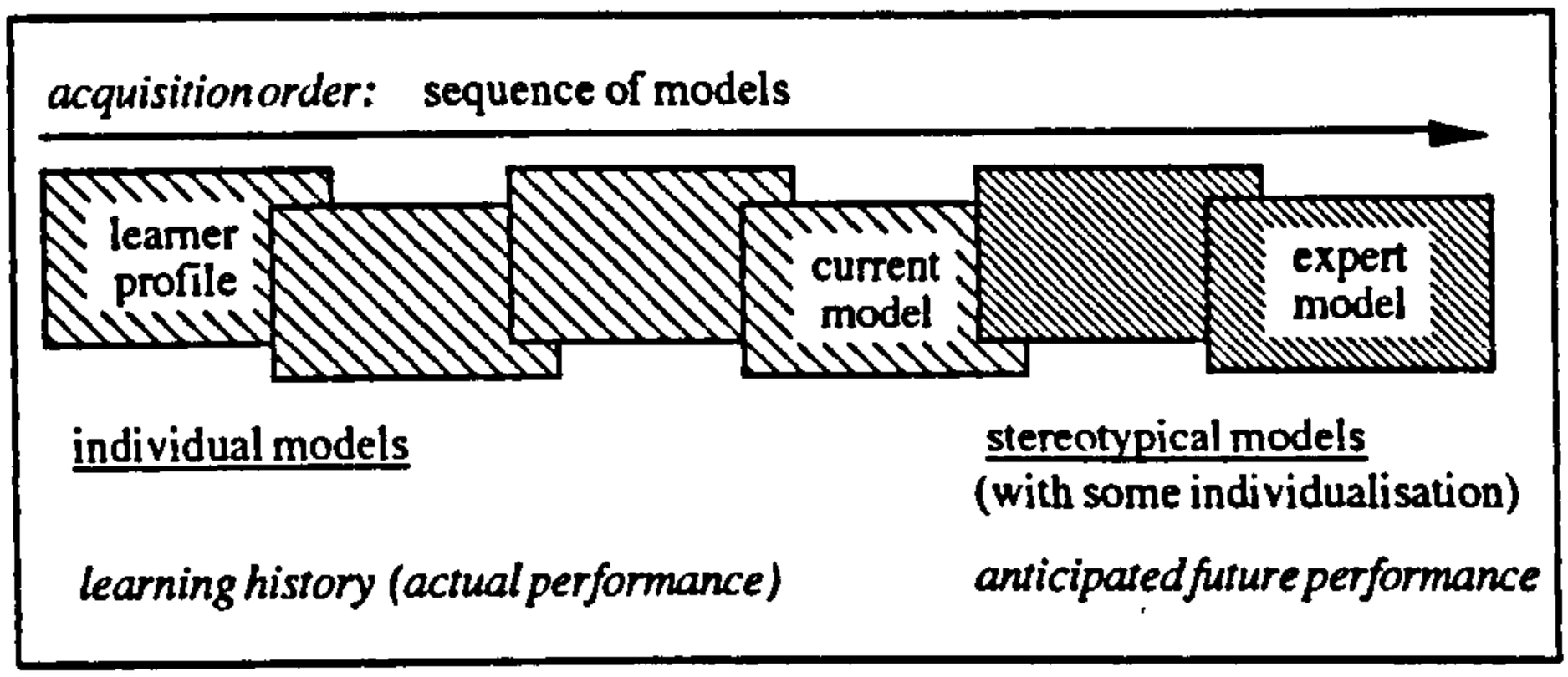

Figure 4.12: The Student Model Continuum II

The initial part of this sequence (from the initial learner profile to the current version of the student model) is formed from a series of individualised models based on a learner's current and previous interactions. The final part of the acquisition order (the anticipated future performance) is represented by stereotypical models based on the typical acquisition sequence observed across many learners. (In a future version of the system these stereotypical models may be enhanced by some individual information depending on the contents of the earlier models. However there should be no individual information in the final expert model, as this contains only knowledge as applied by an expert - in this case a native speaker of European Portuguese.) The more traditional components of knowledge and misconceptions of the domain (based on individual and typical performance) are integrated throughout the acquisition sequence. Figure 4.13 shows the student model continuum in greater detail, with the inclusion of the order of accuracy identified in study 1, as described in section 4.3.1.

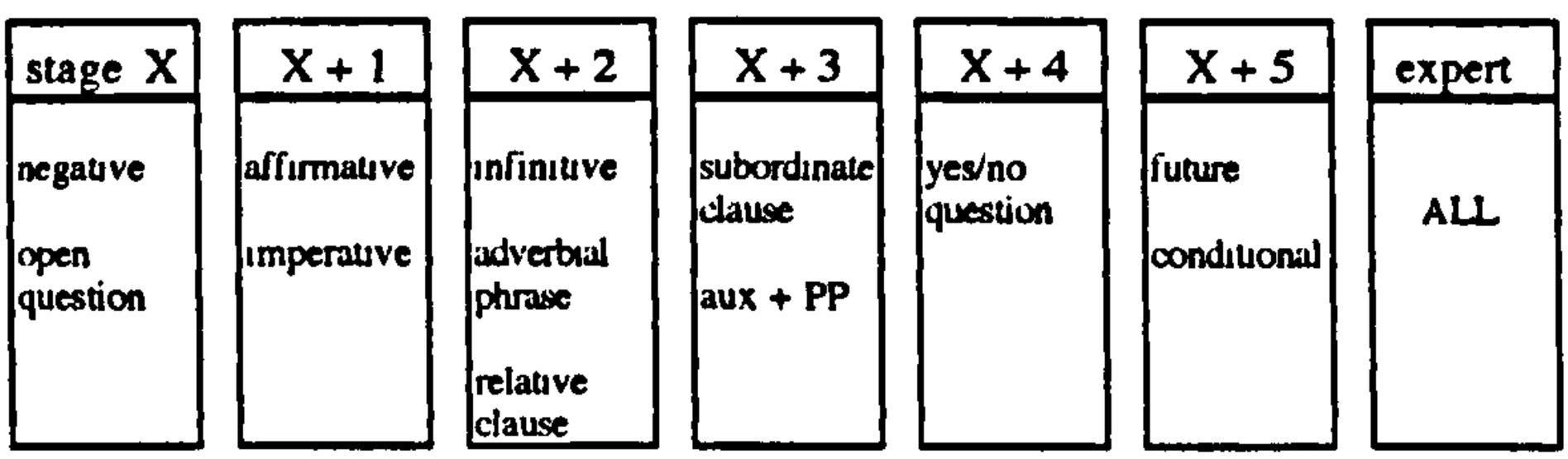

Figure 4.13: The Student Model Continuum III

Figure 4.13 shows that a learner at the first stage, stage X (using Pienemann's (1985) description of stages), will be in the process of acquiring pronoun

placement in negative clauses and open questions. Once the learner has achieved reasonable accuracy in word order in these environments, he progresses along the continuum to stage X + 1: pronoun placement in affirmative main clauses and positive imperatives, and so on, until he (ideally) reaches the status of 'expert'. (Note that the component usually represented as a separate domain model is in this system located on the expert extreme of the student model continuum. Thus it may be used by the system as an autonomous model of the domain, or can also be viewed simply as the final stage of the learning process.) Each stage implies acquisition of the rules at the previous stages.

It has been shown in this section that information about the acquisition sequence for the target rules has been incorporated into the design of the student model; this information may be used by the system to aid diagnosis. However, although an acquisition order can be postulated for the rules of pronoun placement, it is not possible to anticipate a typical order for the appearance of (non-position) pronoun-related errors, as learners can be inconsistent in their production of such errors. For example, study 1 revealed that initially learners often omit the hyphen connecting a post-verbal pronoun to the verb (this may be because in this sample students were never explicitly informed that the hyphen is necessary - though examples were provided with hyphens clearly included). Nevertheless, some learners correctly use the hyphen in earlier stages, but later sometimes omit it. This may be due to carelessness, but whatever the cause, it is necessary for the system to be able to model such behaviour. Furthermore, the fact that a student is experiencing difficulty with a particular rule of pronoun placement does not allow associated non-placement error types to be anticipated. Therefore the student model continuum described above is based on the typical acquisition sequence for the rules of pronoun placement, but a large variety of individual non-placement errors is allowed for at each stage of the learning process.

4.3.3 Parsing According to the Acquisition Order

To illustrate the processes involved in parsing a sentence, the following example sentences will be used. These sentences could be generated by the information contained in the student model (see section 4.1). Discussion will centre on acquisition of the rule to produce sentence 2d.

PREVIOUS STUDENT MODEL -->	CURRENT STUDENT MODEL -->	INTERMEDIATE MODEL -->
1. compra-os	1. compra-os	1. compra-os
2a. * os comprará	2b. * comprará-os	2c. * comprar-los-á
(...other intermediate models where appropriate...) -->	**EXPERT MODEL**	
	1. compra-os	*(he buys them)*
	2d. comprá-los-á	*(he will buy them)*

Figure 4.14: The Student Model Continuum IV

The present situation (as indicated by the *current student model* in figure 4.14) is that the learner knows the rule for clitic pronoun placement in most affirmative declarative main clauses (example 1), but has not accurately acquired the rule relating to the future tense. An earlier state (as represented in the *previous student model*) shows that the learner had been using the rule appropriate in Spanish. The *current model* indicates that the learner is now overgeneralising rule 1 to include the future tense. The *intermediate model* anticipates recognition of the fact that the pronoun must be an infix and it must be prefixed by 'l', though the learner does not yet realise the modifications required to the infinitive[19]. The *expert model* contains only correct rules, the additional information here being the knowledge that when a verb-form ends in 'r' this letter is omitted, and an additional accent on the infinitive is usually required.

In order to determine the nature of an error, the system uses the student model in the following manner:

1. The user's input is first parsed by the *expert* model to discover whether it is syntactically correct. Correct input allows the learner to enter a new sentence, and the parsing process restarts with this second sentence.

2. If the initial input is incorrect, the parse using the expert model will fail, leading to a parsing attempt of the first sentence by the *current* student model. A positive result here will lead to the misconception stage (5).

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19 Various difficulties of the type described in section 4.1 may be apparent here.

3. Failure to parse with the current model will result in an attempt at parsing by the most recent version(s) from the learner's *history;* success in this is indicative of a simple forgetting of rules on the part of the learner[20].

4. Failure to match to a previous history model will result in a parsing effort by the closest *intermediate* model. It has, of course, already been established that there is some error in the input due to the inability to parse at the initial, expert model stage, however if a parse by an intermediate model succeeds (eg. sentence 2c), this is an indication that the learner has in fact progressed, despite having produced a sentence containing an error. (Any sentence parsed by an intermediate model where the current model has been ineffective necessarily indicates advancement.) This progression should be acknowledged (as a form of encouragement) before discussion of the error is commenced.

5. If all parses up to this point have failed, or if there has been a successful parse by the current model, the student model will become 'more traditional' in the sense that it will try to infer any underlying *misconceptions* the learner has. For example, he may be overgeneralising something learnt during a previous session which is inappropriate in the present context (e.g. the rule producing 2b)[21].

6. If all models fail, the final stage involves parsing by the grammars of *other languages* known by the student. The statements provided by the student about proficiency and language distance (see section 4.2.2) are used to determine the order in which the background languages are checked for cases of transfer. The first attempt at foreign parsing occurs with the learner's native language if this is considered similar to the target Portuguese. However, if the learner perceives his native and target languages to be dissimilar, but has another foreign language at a reasonable level of proficiency which is thought to be similar to Portuguese, this language is checked first to try to account for errors based on inappropriate analogy. In general, a language similar to the target is referred to first, although if the learner has only a basic knowledge of this language, it will not be tested until after a more fluent, but dissimilar language has been

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20 Recall Hyltenstam's (1977) assertion that backsliders recede *along the continuum.* In the full system the material concerned would be reintroduced for revision.

21 Here the difficulty should be re-presented together with an explanation and/or examples.

checked - Ringbom (1986) states that there is a threshold of ability which must be attained before knowledge of another foreign language is applied to a great extent in the learning of a new language. (Ringbom was referring here to lexical transfer, but this may apply equally to transfer of word order.) A successful parse by the rules of a background language indicates probable language transfer.

By this stage it is assumed that one of the above parses will have succeeded. However, if the sentence is so scrambled that it has failed all attempts, it is probably too anomalous to be usefully analysed. It would be suggested to the learner that he re-examine any areas of difficulty, or indeed, he should perhaps abandon his current focus and attempt something for which he is developmentally ready.

4.3.4 Evaluation of the Use of an Acquisition Order in Mr. Collins

In section 2.3.1 it was found that there are in many cases identifiable orders of acquisition of L_2 rules, which do not vary greatly across learners. From the student modelling perspective this information could be usefully employed in diagnosis. Therefore an empirical study was undertaken for the target domain of the system. The results of this study were given in section 4.3.1, where the sequence identified was described.

In section 4.3.2 the implementation of this sequence was shown to be possible, in terms of a *student model continuum*, as called for in section 2.3.1. This continuum represents learners' evolving interlanguage through a series of models according to the acquisition order. Although based on *accuracy*, as they relate to the *acquisition* of rules, errors are also allowed for at each stage. Section 4.3.3 described the manner in which parsing occurs in relation to the acquisition order implemented in the student model. The implementation functions as required in terms of probable diagnosis according to knowledge of the *development* of interlanguage. The effectiveness of this in practice still needs to be tested (e.g. will it work for *all* students?). However, as this is only one aspect of knowledge available for diagnosis, for unusual learners who may not follow the sequence as discovered in the empirical study and implemented in the system, other useful knowledge and procedures for diagnosis will still be available.

In summary, it has been shown that an acquisition order *can* be identified for the target rules, and this aspect of developing interlanguage *can* be implemented in the form of a student model continuum to aid in diagnosis.

4.4 Learning Strategies

In section 2.4.4 we saw that the learning strategies below could be usefully incorporated into the ICALL environment, and that these strategies could be separated into three groups, as classified in O'Malley and Chamot (1990):

Metacognitive Strategies:

organizational planning (of strategies), self-monitoring (production/ visual/strategy/double checking), self-evaluation (performance/ability/ strategy use).

Cognitive Strategies:

resourcing, note taking, grouping, summarization, deduction, sub-stitution, translation, transfer, inferencing.

Social Strategies:

cooperation, question for clarification.

The two extreme positions are: the belief that so called 'good strategies' should be taught to all learners, and the contrasting belief that students perform best if allowed to follow their own styles. The position here is that it is not assumed that certain learning strategies will necessarily be best for *all* students; it is considered more important to raise learner awareness of various approaches to learning in order that they may make informed choices about the approaches most useful *to them*. The trial of new strategies is encouraged if the student wishes (particularly if he has a very narrow strategy focus, or is performing badly on the language task), but this is not forced. The system also takes account of student preferences and current approaches.

4.4.1 Learning Strategies in Mr. Collins

Below, as a reminder of the function of each of the learning strategies (and to allow the reader to see how the user can employ these strategies in Mr. Collins), information about the strategies is re-presented together with descriptions of the manner in which students may obtain information about strategies from the system. Students may also inform the system of their view of their strategy use (or indicate the lack of strategy use). This can be done from the option "Your Use of Strategies", which appears after selection of "learning strategies" from the STUDENT MENU. This also enables students to state which strategies they would like to use more (or less) frequently. Although the system also traces students' use of all learning strategies (see section 4.4.3), it is nevertheless useful for it to know how the student views his strategy use. This provides a starting point, and later also a possibly different point of view, enabling comparison between actual and perceived use of language learning strategies. (Such comparison is not yet possible in the current implementation.) Descriptions are given separately for each strategy selected (in order that the system can trace which strategies a student is seeking information about). The information is based on the descriptions by O'Malley and Chamot (1990). The descriptions as seen by the user are given in appendix E.

1. Strategies traced by the system:

METACOGNITIVE STRATEGIES:

Strategy planning involves thinking about appropriate learning strategies to cope with the language task. Students may browse the learning strategies information to find (more) information about strategies, and further, they may ask the system specific questions about (particular) strategies and also about which strategies might be useful for them (by selecting from the options under "learning strategies" on the STUDENT MENU).

Self-monitoring involves checking, verifying or correcting performance during the task. The issues relevant in this system are checking production, which may be in the form of visual monitoring (i.e. whether a sentence looks right), strategy checking (i.e. assessing how well a particular strategy works), and double checking, which includes consideration of alternatives. Students may alter (i.e.

double check) a sentence before it is assessed by the system, by changing it in the dialog box which appears after they have entered their input.

Self-evaluation involves checking performance according to the student's own measures of accuracy, after completion of the task. This includes evaluation of the ability to perform the task, and learning strategy use. Students are requested to tell the system how confident they feel about their sentences by indicating this in the dialog box which appears after input has been entered. This is designed to encourage them to check their performance.

COGNITIVE STRATEGIES:

Resourcing involves the use of any available references, such as books, dictionaries etc. In this system students may refer to grammar rules and/or examples, and may compare Portuguese rules and/or examples to rules and examples in other languages (by selecting "question grammar" from the STUDENT MENU). Students may also ask questions about this grammar. They may access a translation (from "translation") on the STUDENT MENU. They may refer to the student model ("question model"), or may review the trace of their current or previous interactions (in the "interaction" window). They may also consult notes or summaries made by themselves in the "note-taking" window. Eventually a dictionary will also be available.

Note taking involves writing down important or key concepts. This may be with reference to the target grammar, comparisons between the target and another language, notes concerning the use of learning strategies, or aspects of the target rules or exercise which are found to be difficult, etc. Students may make notes (which will be saved by the system) through selection of the item "notes" from the STUDENT MENU. These notes may then be printed if required.

Summarization of information may be undertaken in the note-taking windows available through selection from the STUDENT MENU. (See *note taking*.)

Grouping of information is a useful aid to learning. It may be through ordering, classifying or labelling material according to content. The important factor is that

this grouping of information is meaningful to the individual. In this system separate note-taking windows are provided to assist in the grouping of material.

Deduction involves the conscious application of rules (either learned rules or rules developed by the students themselves). Students may request descriptions of rules by selecting "question grammar" from the STUDENT MENU.

Inferencing is the use of any available clues to predict usage of aspects of the language which are unfamiliar (or to guess meanings in cases of doubt). In this system students may actively pursue inferencing techniques by requesting examples instead of explicit rules, or may explicitly generalise rules already acquired or explained by the system, to include other cases. (This could in some cases lead to correct production, and others, incorrect.) These possibilities may be achieved through selection of the option "question grammar" from the STUDENT MENU.

Substitution involves the selection of an alternative structure to replace one about which a student may be unsure, eg. "Não os quer comprar" instead of "Não quer comprá-los", however, substitution will only occasionally be prompted by the system - for example, if a student has persistent problems with a structure such as the above. Help with substitution of structures has not yet been implemented. Substitution of some learning strategies by more effective ones may also be useful.

Translation here refers to more or less word-for-word translation. This may be useful in cases of real difficulty, but commonly leads to untarget-like production. Students may receive a translation by selecting "translation" from the STUDENT MENU. Translation will rarely be prompted by the system.

Transfer is here defined as the use of rules from one of a student's background languages to facilitate production in the target language. Such transfer may be either positive or negative - i.e. the rules used may be the same or different in the two languages. Transfer can be either conscious or unconscious. It is useful to make (many) students aware of when languages coincide and when they do not. The system advises students of cases of negative transfer as they arise, and suggests possibilities for positive transfer if appropriate when they are experiencing difficulty. Students may find out more about transfer in relation to languages known, and about their own use of this strategy (by selecting "other languages"

from the STUDENT MENU). They may also obtain explicit comparisons of rules of different languages (by selecting "question grammar" from the STUDENT MENU).

SOCIAL STRATEGIES:

Questioning involves asking for explanations, verifications or examples. In this system students may use questioning with reference to the target grammar, relationships between the target and other languages (by selecting "question grammar" from the STUDENT MENU), or with reference to learning strategies (by selecting "learning strategies" from the STUDENT MENU). Students may question or argue about the contents of the student model (by selecting "question model" from the STUDENT MENU).

Cooperation implies the idea of working with others, usually peers. Students will in this case be working together with the system in an attempt to clarify their knowledge and beliefs (both to the system - to create a more accurate student model, and to themselves - to promote reflection). Students may state their beliefs about their learning strategy use at any time, or negotiate their future use of learning strategies, through choosing "Your Use of Strategies", and also ask questions. They may assert their confidence level in a particular sentence by using the dialog box which appears after entering their input. They may discuss grammar (target only, or transfer-related) by selecting "question grammar" from the STUDENT MENU. They may discuss the representations in the student model by selecting "question model" from the STUDENT MENU. The system will initiate discussion on any of the above topics if it requires information, and students are encouraged to cooperate with such requests (they are told that this ultimately results in a more accurate representation of their knowledge in the system, which will in turn enable the system to anticipate their requirements more effectively). The system will, of course, cooperate with all student requests for information.

2. Strategies not traced by the system:

In the case of strategies not traced by the system, descriptions are not stored separately but all appear in the same window. This gathering of information does not occur with strategies actually treated in Mr. Collins as this would result either in too much relevant information being presented at one time, or the student may not

wish to view all information, thus much would be superflous. Further, as stated previously, it is not possible to monitor the student's consultation of information about specific strategies unless this information is presented separately for each individual strategy. Students may access this additional window by selecting "learning strategies" from the STUDENT MENU, and then choosing "Other Learning Strategies".

Students are informed that the information presented in this window is to help them become aware of a wider range of possibilities. They are also told that these learning strategies are not dealt with by the system as this is not the most appropriate context for their consideration. (See appendix E for the descriptions offered to students about these other strategies.)

Strategies used by the system

A few of the strategies are also used *by the system* in a manner which is obvious to the student. As well as being useful strategies for the system, this provides the student with actual examples of good strategy use. Other strategies are also used by the system, but this does not occur in a way which is transparent to the student. For example, the system uses inferencing in its construction of its representations for the student model, and although it will explain its resulting 'beliefs', it does not use such explanations as a focus for later discussing inferencing with the student.[22]

Strategy planning is demonstrated by the system during discussion of which strategies might be useful for a student to try. For example, if a student appeared to be using an approach of 'trial and error', the system might suggest that he try either examining rules or examples, or that he compare with other languages (all of which are aspects of resourcing), and then discuss with the student what would be the most appropriate strategy for him (depending on the student's intuitions, and also on the types of strategy the system has observed the student to be already using). The student here receives a model of how to consider the appropriacy of different learning strategies.

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22 Although, in theory, it could. The question here is whether it is a good idea to focus on a possibly incorrect student belief as the object when explaining inferencing. Alternatively the sytem could use only those representations which match correct performance. Thus may be a matter for investigation.

Resourcing is also undertaken by the system when it is seeking explanations for the user. It may retrieve information from many of the same places as the student (for example, relevant sentences from the interaction trace, grammar rules, examples, comparison with other languages, etc.). Although the system does not explicitly describe its actions as resourcing at the time it is carrying this out, the student will see that the information presented comes from different places, and will thus be reminded of the variety of sources of information available for consultation.

Summarization is also demonstrated in system explanations. Each source used by the system is not presented in full; only the relevant parts are drawn on[23]. Thus the student will see, for example, that the system only refers to that part of the previous interaction which is important to the point it is making, and does not present the whole trace. Similarly the system will only present relevant rules or examples in Portuguese, or the equivalent rules or examples in other languages, etc.

The *grouping* strategy is also used overtly by the system in its presentation to the student of some of the available information. For example, figure 4.15 shows how, if the student requests to view all twelve rules of Portuguese pronoun placement, these are presented in different areas on the screen, according to the position of the pronoun.

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23 In Mr. Collins, summarization as a learning strategy is concerned with summarization of *relevant* or *important* information, and not summarization of all available information.

The pronoun is preverbal in:	The pronoun is postverbal in:
negative clauses	affirmative main clauses
open questions	positive imperatives
certain adverbial phrases	infinitives
relative clauses	yes/no questions
subordinate clauses	

The pronoun is an infix in:	The pronoun is between:
future tense	auxiliary & past participle (main clauses)
conditional tense	

Figure 4.15: example of system grouping (Portuguese pronoun placement rules)

The same layout is used for the presentation of examples of the use of these rules, and also for the presentation of a combination of rules and examples. Similarly, a learner wishing to view information about the similarities and differences between rules of different languages (see section 4.2), will receive this information separated according to these differences and similarities, as depicted in figure 4.16[24] (examples for affirmative main clauses, for a learner who knows English, Spanish, Catalan and French).

24 See also figure 4.8.

Pronoun in same position:	Pronoun in different position:
Portuguese:	
Compra-os	
	Spanish
	Los compra
	Catalan
	Els compra
English	
He buys them	*French*
	Il les achète

Figure 4.16: example of system grouping (similarities and differences in different languages)

It is intended that separating information into groups according to some such salient feature, and presenting this information on different areas of the screen, will aid the student in his remembering of these items. It also provides examples for the student of use of the strategy of grouping. (This type of presentation strategy is being further investigated by Musson and Bull in the *Cognate?* system (see section 2.4.3), where other learning aids based on presentation are available. Results of this research may later be used to further enhance Mr. Collins' presentation of information.)

In its maintenance of the student model the system also uses the strategy of *questioning for clarification* when it is unsure about which of two (or more) alternatives is the correct representation of the student's beliefs. As well as providing information needed by the system, this also offers the student a model of the strategy of questioning.

Similarly the strategy of *cooperation* is made transparent to the user, as the system cooperates with all student requests. It will also try to involve the student in negotiation where relevant.

Figure 4.17 below indicates the manner in which the learning strategies are inter-linked in Mr. Collins.

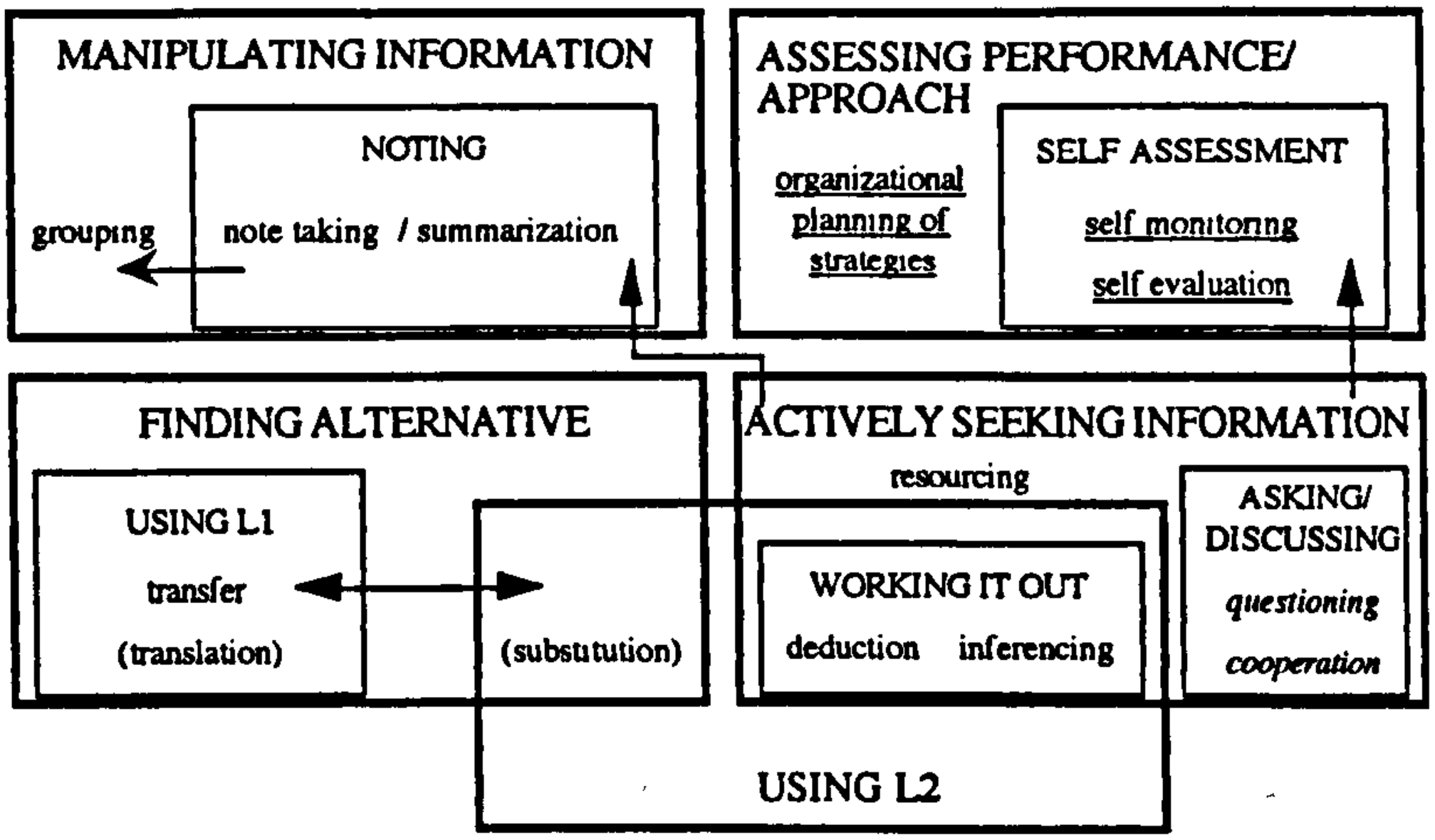

Figure 4.17: learning strategy groupings
Key: underlined = metacognitive strategies, plain text = cognitive strategies, *italics* = social strategies, (bracketed strategies) = less useful strategies, CAPITALS = categories and sub-categories

The links are in addition to the three-way distinction between metacognitive, cognitive and social strategies as described above; the additional categorisation was developed in order to enable Mr. Collins to more easily suggest alternative or additional strategies to students, depending on which strategies are currently used or known by the individual. Thus, a strategy within the same 'boundary' or category as another strategy which is already used (e.g. deduction and resourcing), will be easier for the system to explain and introduce to a student than a strategy from outside the boundary. Subsets within categories reflect even closer relationships between certain subcomponents, and it should therefore be even easier to move between strategies in these subcomponents (e.g. deduction and inferencing). In addition there exist three connections between less closely related groupings of strategies (marked by solid arrows). These connections indicate that, although there are some fundamental differences between the groups concerned, there is some quality which makes progression from one set to another relatively easy to introduce. (This progression is not necessarily bi-directional.) The 'ease of introduction or discussion' factor is expected to coincide with ease of comprehension on the part of the student, as strategies within the same boundary, or those which are otherwise linked, are in some way conceptually closer. (This is

not a psychological observation, but is based purely on intuition. The groupings are to enable *this system* to function usefully in its handling of learning strategies.)

MANIPULATING INFORMATION

The top, left-hand box contains three cognitive strategies concerned with the manipulation of information. Although Mr. Collins is able to detect when the strategy of *note taking* or *summarization* has been used, it is not able to distinguish which of the two strategies was used unless the student explicitly informs the system. Therefore these strategies will tend to be treated in an identical manner in the system. However it is easy to see, for example, that if a student were already using one or both of these strategies, but was not *grouping* information, it would not be difficult for the system to introduce the *grouping* strategy to this student. The reverse is less likely; the student will not be already *grouping* information unless he is already *noting* it down, or making a *summary*, i.e. if he does not *note* or *summarize* (some type of) information, what is it that he should *group?*

ASSESSING PERFORMANCE / APPROACH

This box contains three metacognitive learning strategies, two of which (*self-monitoring* and *self-evaluation* - defined as SELF ASSESSMENT), are more closely connected to each other than they are to the third (*organizational planning of strategies*). Thus for a student who evaluates his performance against some (external or internal) measure once his work is completed, it is not a great leap to suggest that he extend this type of evaluation to the monitoring of work while it is still in progress, and vice versa. Extending this notion of assessment of performance to the assessment and planning of approaches to learning will also be relatively unproblematic, as will the reverse: moving from *organizational planning of strategies* to the SELF ASSESSMENT strategies.

FINDING ALTERNATIVE

The strategies in this set are all cognitive learning strategies, and are concerned at least partly with finding an 'alternative', or a way around a problem. With *transfer* in particular, this may or may not be a conscious action. Two of these strategies, *transfer* and *translation* (defined in sub-group USING L_1), are L_1

focussed (or concerned with another L_2 apart from the current target language). The other, *substitution*, is concerned directly with the target language. *Translation*, as previously discussed, is not necessarily positive, and would not tend to be encouraged. The distance from word-for-word *translation* to the potentially more beneficial *transfer* of word order rules is comparatively small. *Substitution* is, as already stated, an avoidance strategy, and it is therefore better to overcome the use of *substitution* if possible. However, if a student experiences persistent difficulties with a particular construction it may actually be useful to suggest attempting alternative solutions. A student who already uses L_1 based strategies will probably grasp the idea of *substitution* with little difficulty. Similarly, a student who exhibits *substitution* could be encouraged to use positive *transfer* if appropriate, in order to diminish the need to *substitute*.

ACTIVELY SEEKING INFORMATION

This set contains three cognitive strategies (*deduction*, *inferencing* and *resourcing*), and the two social strategies (*question for clarification* and *cooperation*). This is the only mixed set. It is composed of the strategies learners use when actively trying to find out more information. Acquiring one of these strategies in addition to another (already used) from this group, should be relatively simple for a student (as compared to moving from translation to cooperation, for example). The two social strategies form a sub-group: ASKING/DISCUSSING), and two of the cognitive strategies (*deduction* and *inferencing*) comprise their own sub-set: WORKING IT OUT. Therefore the extension from *questioning* to *cooperation*, should be relatively easy for a student to achieve, and also for the system to explain or introduce. Likewise it is not a great conceptual jump from *deduction* to *inferencing*, or from *inferencing* to *deduction*. Although a step further away, it is also relatively easy to move between the two sub-groups ASKING/DISCUSSING and WORKING IT OUT, and from either of these to the strategy of *resourcing*, and from *resourcing* to one of the strategies in either of the two sub-sets.

There are two additional links connecting strategies in the group ACTIVELY SEEKING INFORMATION with some strategies from outside this group. The first is with the NOTING strategies in the group MANIPULATING INFORMATION. Clearly, if a student has sought information in some manner (e.g. *resourcing*, *questioning*), he may usefully manipulate this information in some way. Similarly, though a

different type of process, if a student has sought information he may be encouraged to use this information as a measure against which to assess his own performance. Hence the link to the metacognitive strategies of SELF ASSESSMENT in the category ASSESSING PERFORMANCE/APPROACH.

USING L_2

This final group overlaps partially with two of those described above: FINDING ALTERNATIVE and ACTIVELY SEEKING INFORMATION. There are no strategies in USING L_2 which are not also in either of these other two groups. Nevertheless, USING L_2 is a category in its own right, equal to the other four groups described above. USING L_2 is composed of learning strategies which involve using the target language directly. It contains *substitution* from FINDING ALTERNATIVE, and *deduction* and *inferencing* which together comprise the sub-group WORKING IT OUT, which is included in ACTIVELY SEEKING INFORMATION. There is a connection between *substitution* and the strategies in WORKING IT OUT, in the same way that there is a connection between *substitution* and the strategies in USING L_1 (as described in FINDING ALTERNATIVE, above).

Finally there is an additional, bi-directional link between USING L_2 and USING L_1 (in FINDING ALTERNATIVE). A student who uses overwhelmingly L_1 focussed strategies should be able to appreciate the difference between these and the L_2 based strategies, and vice versa.

SUMMARY OF MOTIVATION FOR GROUPINGS

This further categorization of the strategies selected from O'Malley and Chamot (1990) is used as a means to guide Mr. Collins' management of its introduction of new strategies to students. It will still, of course, try to avoid the prompting of 'less desirable' strategies for this context, such as *translation* and *substitution*, and also take account of student preferences, but in its presentation and discussion of strategies it will base its movement around the strategy domain at least partly on the 'relative closeness' of those strategies already used by a student, to those to be introduced. In student initiated discussion it will naturally answer the questions asked by the student, but if possible it will tailor its response to include a relevant context of 'similar' strategies already used, to those under discussion. This

'closeness' factor is a more useful guide for the system to follow than some measure of total frequency of use of different strategies, because, as Politzer and McGroarty (1985) point out, the use of a particular learning strategy may be the result of good learning behaviour, or it may indicate a simple lack of progress! In the latter case, it might be more useful to try a different strategy from those currently used.

4.4.2 Obtaining Initial Information: the Learner Profile

In order that Mr. Collins does not initially have to infer a student's learning strategy use from scratch, and also because of the open philosophy of the system, at the start of a learner's first interaction with the system it will discover a student's current strategy use, and record this in the initial learner profile. O'Malley and Chamot (1990), O'Malley et al (1985) discovered that it is the students themselves who are the most detailed source of information regarding their use of learning strategies (as opposed to teacher reports or the conducting of observations), therefore self-reports are employed here. Before study with Mr. Collins can commence, the student is asked whether he would be prepared to try alternative learning strategies if these were considered more appropriate than his own strategies, or if he would be prepared to broaden his strategy use. This is an important question, as a readiness to try new strategies may result in an initial slower rate of learning in the intended domain, and some learners could lack the necessary time to adopt this approach. Although this aspect of the system is based on the notion that the strategies learners use may affect the level of success they attain (Abraham & Vann, 1987), it is not felt necessary to prevent those learners who do not wish to discuss strategies from using the system. Indeed, they may eventually be in a position to wish to explore this aspect of learning. Therefore if a student states that he is unwilling to consider alternative strategies, no further discussion will be prompted by the system, and those parts of the program which track these matters become (temporarily) blocked. (However, early results indicated that students *would* be enthusiastic about considering alternative learning strategy use (see section 4.4.6)).

If the learner does wish to discover more about the use of learning strategies (or to delay the decision about whether to pursue the search for effective learning strategies), strategies are introduced in the three groups identified by O'Malley and

Chamot (1990): metacognitive, cognitive and social (see section 2.4.2 for definitions). This form of presentation is more likely to alert the student to the fact that there are a wide variety of possible strategies, and further, the groupings[25] will focus his attention on alternatives which indicate the use of entirely different general approaches to language learning. After considering the information provided about strategies, the student indicates by menu selection which he normally uses, in order to assist future diagnosis and discussion. Such knowledge allows the system even in early interactions, where it has not yet had the opportunity to trace strategy use, to offer suggestions of appropriate strategies *for that student*.

Figure 4.18 below shows some examples of information which could be provided to a student requesting to view representations in the system about his own strategy use, and the implications of their use. (These are simple, separate examples restricted to the actual strategies the student has stated using, and does not consider the relative frequency of use, or success of use. This is the type of information given to a learner who is new to the system, and is based on the learner profile. In later stages knowledge in the system about the student's approaches to learning would be more detailed, and thus more complex descriptions would be provided - based both on the student's claimed use of strategies and the system's monitoring of his actual stategy use (see section 4.4.3).) The information about which strategies are used is retrieved from the learner profile, and relevant additional information is added via templates.

METACOGNITIVE STRATEGIES:

The fact that you reported using both *self-monitoring* and *self-evaluation* indicates that you are especially likely to check your performance (both during and after task-completion). These are very useful strategies.

The fact that you reported using *self-monitoring* indicates that you tend to check your performance. You could enhance such checking by also considering *self-evaluation* techniques when you have completed the task.

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25 Note again the system's use of the grouping strategy.

The fact that you reported using *self-evaluation* indicates that you tend to check your performance. You could enhance such checking by also considering *self-monitoring* techniques while carrying out the task.

The fact that you reported using neither *self-monitoring* nor *self-evaluation* indicates that you are unlikely to spend much time checking your performance. These would be useful strategies in many contexts.

COGNITIVE STRATEGIES:

The fact that you use *transfer* and also *inferencing* and *substitution* indicates that you tend both to use strategies concerned directly with the target language, and also refer to other languages. In your case you are likely to rely on French when using *transfer*.

The fact that you reported using both *transfer* and *translation*, but do not use the Portuguese-focussed strategies, and also that you consider Spanish to be similar to your target language, and because you have a high level of proficiency in Spanish, this suggests that you are especially likely to refer to Spanish when learning Portuguese. Although transfer can be positive (and therefore very useful) when the rules of two languages coincide, it must also be remembered that the rules of similar languages are not always identical.

The combination of your use of the three strategies *deduction*, *inferencing* and *substitution* shows that your learning strategies tend to be very strongly focussed on the target language, with less influence from other languages known. This observation is further strengthened by the fact that you do not report using the strategy of *transfer*.

The combination of the strategies of *note-taking* and *summarization* show that you are very keen on noting down new or relevant information. It would be useful also to consider the *grouping* of information; i.e. organising new or important information in some manner which is meaningful to yourself. (There are no rules here; the crucial factor is that your groupings have some meaning to you.)

You report using NO SOCIAL STRATEGIES.

Figure 4.18: examples of learning strategy information deduced from the learner profile

Having access to the type of information illustrated in figure 4.18 at such an early stage will help the student to reflect on his use of learning strategies to aid his attempts at changing them where this would be beneficial and acceptable to the student. Such reflection has been shown to facilitate strategy change - see Holmes and Ramos (1991).

4.4.3 Maintaining Information: Tracing Learning Strategy Use

In order that Mr. Collins can sensibly discuss with students their own particular uses of learning strategies and suggest reasonable alternatives or additional strategies, it must be able to maintain an independent representation of what the student actually *does* (i.e., although taking account of student statements and information in the learner profile, it should not rely *only* on what the student says he does). Therefore all strategy use is also traced by the system. This occurs as defined below:

METACOGNITIVE STRATEGIES

The student's *organizational planning of strategies* is monitored by the system through tracing occasions when planning-related interaction occurs. The system notes which partner has initiated discussion, and a double accumulative score (relating to student or system initiated discussion) is maintained. This enables the system both to track the willingness of the student to consider organizational planning when prompted (i.e. whether he cooperates during system-initiated discussion), and to record how often this initiative actually comes from the student. Such interaction takes place in menu-format, i.e. the learner may start discussion through selection of the relevant item from the student menu. The system will then respond by offering alternatives, for example: suggestion of appropriate strategies, or explaining why one approach may be more effective than another, etc. The learner may then indicate which type of information is required. System-initiated discussion follows a similar format. (The student may of course decide to ignore any system-prompted discussion; here the system would note the disinclination of the student to interact on the subject, and would try to reinitiate discussion at a later time.)

The student's *self-monitoring* and *self-evaluation* is similarly monitored. The system can request the learner to state the manner in which he has approached tasks (through selection from a menu), or the learner may volunteer this information at any stage through use of the student menu. The student is encouraged to state his confidence with regard to the correctness of each sentence entered, via a dialogue box which appears after the input of the sentence. This dialogue box is designed to encourage self-monitoring behaviour. The dialogue box also enables the learner to retrieve his sentence for alteration before it is parsed by the system, to allow him to perform delayed double checking. Discussion of the strategy of self-monitoring provides information to the system on how the learner regulates his language production and strategy use, and promotes learner reflection on his learning and approaches to learning. Discussion of self-evaluation provides information on a student's beliefs about his performance, ability and strategy use.

COGNITIVE STRATEGIES

The student's use of the strategy of *resourcing* can be easily traced by the system, it simply records how often the student asks questions about the domain, how often he inspects the grammar rules, examples, student model and his own notes, his use of the dictionary (not yet implemented), how often he reviews the trace of his current and previous interactions, how often he requests a translation and how frequently he compares Portuguese rules and/or examples to rules and/or examples of other languages. If it is felt advantageous for the system to suggest increasing the student's use of any of the above (in cases of less than optimal performance in the target language), this can be suggested and the reasons stated.

Note taking or *summarization* can similarly be easily traced; this is purely a question of checking how frequently the learner uses the note-taking windows (assuming that he can be persuaded to make use of them, and subsequently print the information if required in preference to making notes directly on paper). *Grouping* is indicated by the student's use of separate note-taking windows, rather than recording all information in a single window.

The strategies of *translation* and *transfer* are tracked automatically. Transfer is recorded if appropriate when the student's input is parsed by the rules of other languages. Incidences are dealt with as they occur, but the student may also ask

questions with respect to his own input and how this relates to his background languages, via the student menu. In such cases, the system parses the sentence entered with the rules of Portuguese and other languages known by the student, in order to determine the source of transfer (and will note this use of transfer). Translation is recorded as having potentially occured if a student explicitly requests a translation of the target exercise sentence. (However, it should be noted that a student could simply be using the words as an alternative to seeking the meaning of a single word in the dictionary. The use of translation can only be guaranteed to have occurred if the student explicitly states to the system that he is translating.)

The use of *inference* can be traced by student requests for examples rather than explicit rules, or attempts to explicitly generalise rules to include other cases based on knowledge of rules already acquired or explained by the system. Conscious application of rules can be reported by the student to indicate the use of *deduction;* the student may also request rules to work from.

Substitution is evident if a student is having problems with a particular construction (e.g. Não quer comprá-los) and after one or more failed attempts, switches to an alternative (e.g. Não os quer comprar). Substitution may be prompted by the system if it is felt that the alternative may be developmentally more suitable to the learner's current level.

SOCIAL STRATEGIES

General *questioning* is traced when the student requests information in cases where he is unsure of a rule or example, or an aspect of his own input or representation in the student model. Likewise, requests for verification are noted. Accumulative scores for instances of the various types of questioning are maintained, and should any score appear inappropriately low, the system will remind the student of the benefits of using this approach.

Cooperation occurs automatically to some extent as the whole system is based on the notion of collaborative student modelling. Also, the future use of learning strategies can be negotiated. However the extent of cooperation may vary across students (and, indeed, with a single student across time). The system will record the degree of attention that the student pays to system suggestions (i.e. whether he

carries them out), and also the amount of information that the learner contributes (voluntarily or after prompting) with respect to his own beliefs, plans etc.

Figure 4.19 is an example of an individualised description of a student's use of a learning strategy, which is based on the system's tracing of his strategy use. The example presented is for resourcing. The type of description presented below will be given on student request, or as part of a longer system explanation.

You tend to use the strategy of resourcing quite frequently.

You ask questions when you are unsure.

You refer to the grammar rules.

You tend not to request examples.

You occasionally use a translation.

You often compare to the rules of other languages.

You view the student model (however you do not challenge it when you disagree).

You sometimes review the trace of your interaction.

You do not consult notes that you have previously made.

Do you wish to discuss the use of examples, challenging the system or consulting notes?

Do you disagree with this description?

- discuss the use of examples
- discuss challenging the system
- discuss consulting notes
- disagree
- no
- no (and comment)
- (cancel)

Figure 4.19: example of individualised learning strategy information deduced from strategy tracing

As stated above, this account is based on the student's actual use of strategies. The description provided is followed by the suggestion that the student may like to follow up on the three aspects which he does not use, as the system views this as an appropriate moment to introduce these. The student may refuse (with or without explanation), or may disagree with the system's assessment, and pursue this, or may decide to try, or find out more about one or more of the strategies suggested. Challenging the system in cases of disagreement is likely to be very useful for the student, as it should promote reflection. Benefits of the use of examples will tend to depend more on the individual's preferred general approach to learning

situations. Consulting notes made earlier will be useful if the student has forgotten the information he noted. However, it should be clear that sometimes the act of making notes is sufficient to learn or understand the information.

4.4.4 Moving between Strategies

A student may decide to use a new learning strategy at any time. This may be as a result of previous interactions with the system about learning strategy use (for example, after system prompts to try a particular strategy), or may be a result of the student's own (unprompted) desire to try a different approach. In this section, the manner in which the system uses the groupings between strategies (as shown in figure 4.17), to help the student's selection of a useful strategy, is described. It is important to emphasise here that although the system will respond to all student enquiries, it will itself only initiate interaction about learning strategies if the student is not performing well on the language task.

As a starting point, the system determines from the learner profile or previous interactions which strategies the learner tends to use. It then compares this information to the O'Malley and Chamot (1990) three group classification (metacognitive, cognitive and social), to see how broad the learner's strategy use is. For a learner who wishes to broaden his use of learning strategies, but does not have any specific suggestions of his own, the following route is used:

1. A student who uses no cognitive strategies will first be introduced to those in the sub-category of NOTING.

2. A student who uses no metacognitive strategies will first be introduced to self-monitoring and/or self evaluation. This is particularly relevant if he already uses some of the strategies from the category ACTIVELY SEEKING INFORMATION.

3. A student who uses no social strategies will be introduced to questioning if his general use of learning strategies is quite broad. If the learner does not have a broad range of strategies, the system will instead try to build on those strategies already used (as described below in figure 4.20).

It can be seen that it is considered important for a student to be aware of a variety of different types of strategy (though strategy use will depend partly on the individual). The choices of starting point, as described above, are explained as follows. These explanations are in terms of the further categorisation of O'Malley and Chamot's (1990) classification, as presented previously in figure 4.17.

1. Cognitive learning strategies are the largest group. A learner who does not use any of these strategies[26] is therefore likely to have a very low overall incidence of useful strategy use. Therefore the strategies to be suggested here must be simple to comprehend. (More complicated approaches can be left for future interactions.) The NOTING (note taking/summarization) strategies are the most obvious, as this concept is very ordinary.

2. All three metacognitive learning strategies are found in the category ASSESSING PERFORMANCE/APPROACH. It is easier to introduce the idea of the SELF ASSESSMENT strategies (self-monitoring and self evaluation) to a student who does not use a great many learning strategies, than it is to introduce organizational planning of strategies. (If a learner does not use many different strategies, it may be less obvious how he should organize them.) It is probably also more important to initially encourage SELF ASSESSMENT than strategy planning to a student who uses a variety of strategies (but which does not include any metacognitive strategies). Strategy planning can be introduced later.

3. The social strategy of questioning is useful, and it is particulary appropriate to introduce this if a learner already uses a variety of (metacognitive and cognitive) learning strategies. Cooperation, although also useful, is harder to conceptualise as it is a two way process, and it is therefore easier to leave this until the strategy of questioning is familiar.
   However, if a learner uses only a limited set of strategies, it is considered more useful to build directly from those already used, as the idea of learning strategies is clearly not obvious to the student. Such a student is likely to be more receptive to a more obvious elaboration of his present approach. Questioning (and cooperation) can be introduced later, as appropriate.

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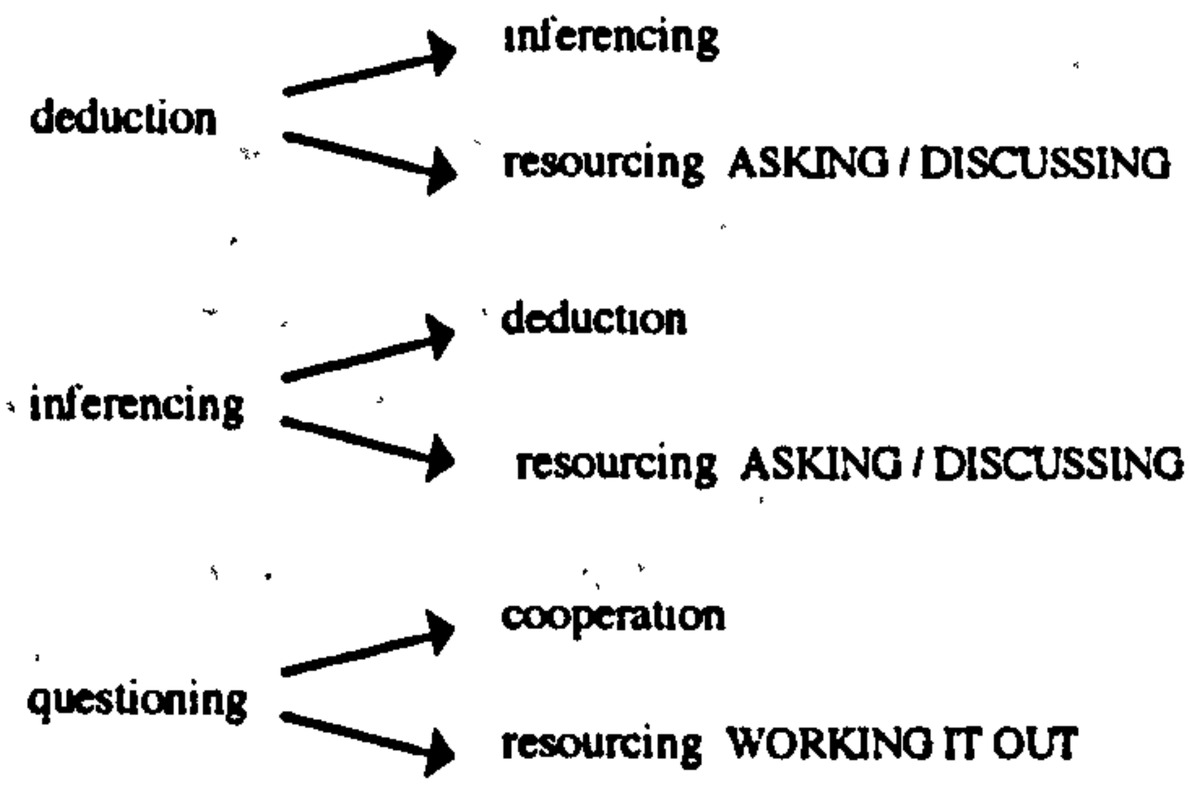
26 This is an unlikely situation, but must be allowed for.

The following illustrates the next stage: the system's discouragement of the more negative strategies[27]. (Again, this will occur only if the learner has no specific request.)

1. A student who uses translation will be encouraged to substitute the strategies in WORKING IT OUT (deduction and inferencing), if he already uses other INFORMATION SEEKING strategies. Otherwise he will be introduced to the idea of transfer, if this is new to him.

2. A student who uses the strategy of substitution will be encouraged to use deduction or inferencing instead. If he does not wish to try either of these, the system will suggest transfer.

Figure 4.20[28] illustrates the next stages of the introduction of, explanation of, and encouragement of use of learning strategies. This occurs unless the learner requests discussion of a particular strategy or set of strategies. Strategies are presented and described depending partly on those strategies already used successfully by the student. Thus, although the sequence below would be the ideal sequence for some students, others may start at a different point in the list (moving later to those higher in the list). Recall that this order is simply to provide the system with heuristics to guide its strategy selection in cases where the student does not offer suggestions of his own.



27 'Negative' strategies must be included in the system, and be visible to the learner, if the system is to try to discourage the use of such strategies.

28 Programming of the information in figure 4.20 was done by Matt Smith.

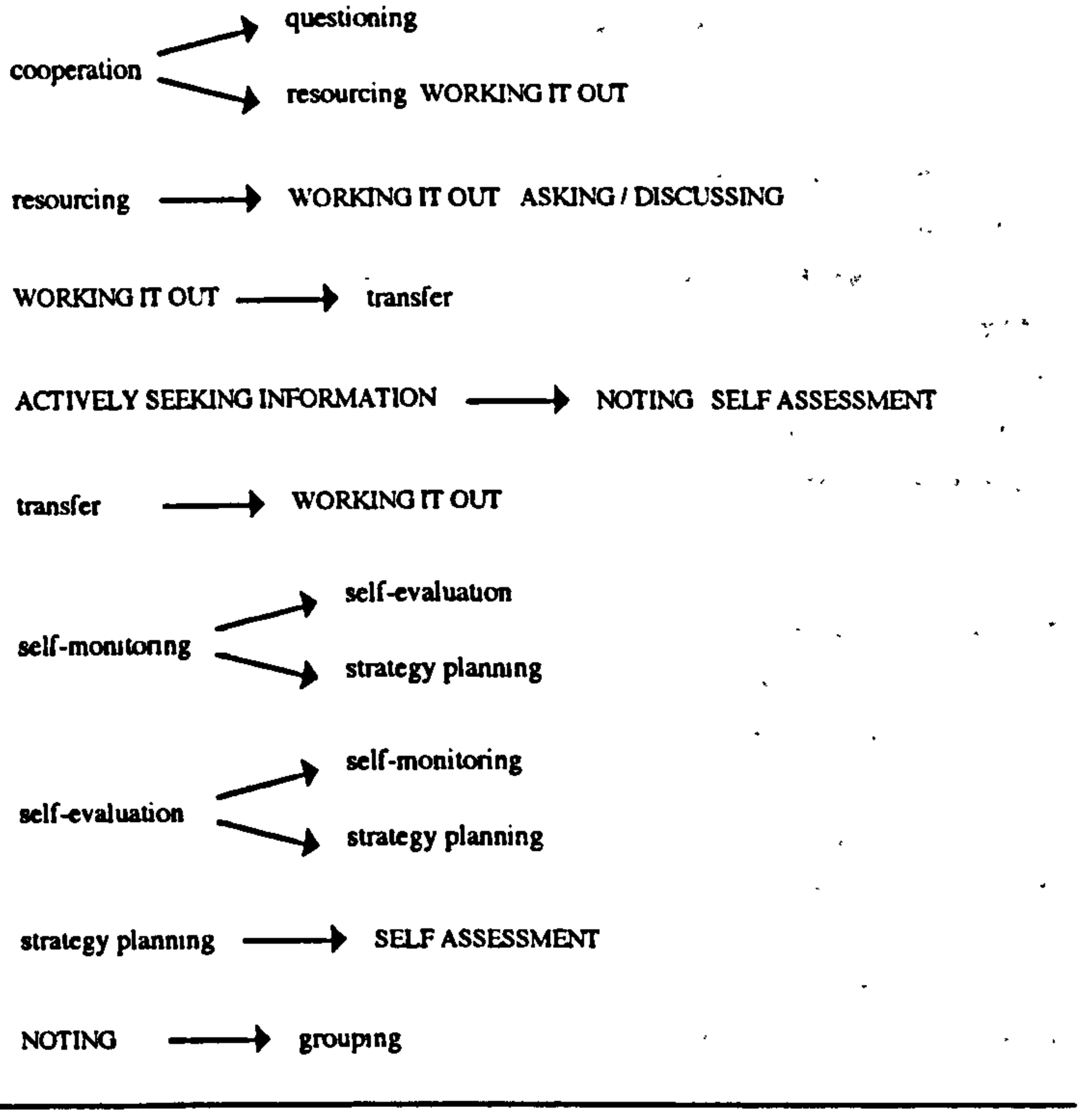


Figure 4.20: moving between learning strategies

Figure 4.20 should be read as follows:
A student who uses deduction will first be introduced to the strategy of inferencing, if this is not already used. However, if the student explicitly states that he does not (currently) wish to consider inferencing (or if he already uses inferencing), the system will instead try to introduce resourcing or the strategies in ASKING/DISCUSSING. Should the student wish to try none of these, but still be eager to find out more about learning strategies, the system will search down the list until it reaches the next strategy (on the left hand side of the figure) which the student already uses, and which contains at least one suggestion (on the right hand side) which the student does not use and has not vetoed. If the first case (for deduction) has already been passed through completely, either the student is now

aware of, and maybe uses these strategies, or has decided not to consider them at the present time. Therefore the system will not try to introduce the next groups: those leading from inferencing, questioning, cooperation and resourcing. It will here move on to suggest transfer, as this leads on from WORKING IT OUT, which contains deduction, (a strategy which *is* used, as can be seen from the beginning of the description of this example).

There are other issues which are also taken into account in addition to the 'closeness' of learning strategies. For example, the student is encouraged to inform the system about things he feels he has difficulty with. For example, a student who says he thinks *too much* in terms of a background language, or demonstrates such behaviour, is directed towards the Portuguese-focussed strategies. A student who considers himself bad at self assessment, or demonstrates this by having belief measures consistently incompatible to those of the system (see section 4.6), would be encouraged to compare his input directly with information in the expert domain model. A student who claims he forgets easily, encounters the suggestion that he should make (more) notes. A student who feels he uses dictionaries far too frequently will be directed towards trying inferencing for word meanings.

Students are also encouraged to state which previous language learning experiences were good and bad for them. This information is then be matched to appropriate learning strategies. For example, a student who does not like grammar would encounter the suggestion that he could work more from examples. A student who likes grammar and structure is offered explicit rules. A student who dislikes a too communicative bias may also be offered explicit rules. A student who dislikes teacher dominance is directed towards resourcing and questioning. A student who likes having an expert teacher available to verify information or answer questions could question the system. Note that questioning is suggested for a student who dislikes teacher dominance as well as for a student who prefers the availability of an expert teacher. In the latter case the student is questioning the system in its role of expert. In the former case the student would view the system more in terms of a resource. Although effectively these are identical behaviours, the perspectives differ.

In the previous sections we have been considering how the system keeps up to date with students' use of learning strategies, and how it is able to suggest further

appropriate strategies. It should be noted that in this system, although learning strategies can be presented and discussed, there is no attempt to *directly* teach the use of learning strategies. This may not always be desirable, and is an issue for further research. The aim here is to raise learner awareness of the range of strategies available, and to encourage a learner to reflect on what may work best for him as an individual. The next section describes the manner in which the system is able to take account of students' views about what might work for them.

4.4.5 Discussion of Learning Strategy Use

In addition to viewing information about their learning strategy use, students may also discuss their future use of learning strategies[29]. The example in figure 4.21 may have occurred after system prompting, or a student request for interaction about learning strategies. This is a hypothetical interaction (i.e. with an experimenter acting as student) based on the current implementation.

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system:

As you already use deduction efficiently, you might like to try a complementary strategy: inferencing.

Do you wish to try inferencing, or find out more about this strategy?

- try inferencing
- no
- (cancel)
- find out more
- no (& comment)

student (selects):

find out more

system:

Deduction is based on rules

e.g. from the rule 'the pronoun is preverbal in negative clauses' you know that the pronoun must be placed before the verb in this context.

Inferencing is similar, but you use examples rather than explicit rules

e.g. from the example sentence 'Não os compra' you can INFER that the pronoun must be placed before the verb in this context.

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29 Students may, of course, decide to try new learning strategies without prior discussion.

You may find inferencing useful (in addition to deduction), or you may prefer to stay only with deduction, as these two strategies are not equally suited to all learners.

Do you wish to try inferencing?

- yes
- no
- no (& comment)
- (cancel)

student (selects):

no (and comment)

system:

Please select one of the following:

- this does not feel right FOR ME
- this does not feel right FOR ME (& comment)
- I would prefer to try another strategy
- I would prefer to try another strategy (& comment)
- I would like to come back to this later
- I would like to come back to this later (& comment)
- none of the above
- (cancel)

student (selects):

this does not feel right FOR ME (& comment)

system:

Please state your reason for saying that inferencing does not feel right for you.

- I need rules
- I do not (yet) feel confident enough to use inferencing
- none of the above
- (cancel)

student (selects):

I need rules

system:

Is there a specific strategy you would like to try?

- yes
- no
- (cancel)

student (selects):

no

system:

As you already use deduction and questioning for clarification, it would be useful for you to consider one of the other information seeking strategies: resourcing or cooperation.

Would you like to try either of these, or find out more about these strategies?

- resourcing
- cooperation
- find out more
- no
- no (& comment)
- (cancel)

student (selects):

resourcing

Figure 4.21: example discussion about future learning strategy use

In this example the system suggests that since the student can already use deduction, he could also consider inferencing. This strategy has been suggested due to the link between learning from rules and learning from examples. However, it is also acknowledged that some people prefer only one of these approaches. Recall here that new strategies are suggested based on a principle of 'ease of introduction and comprehension on the part of the student'. This is particularly important when learners are unused to the notion of learning strategies. Therefore, although a student may feel that inferencing is inappropriate for him, he is able to make an informed decision, as he understands the purpose of the strategy. The current student is such a learner, and explains that for him, rules are the most important thing[30]. The system now knows not to try to reintroduce inferencing (as it would have done, had the student indicated that he currently did not feel confident enough to use this strategy). Other students at this point may be eager to try this alternative approach, as it is familiar in the sense that the mechanism of 'working it out' is similar to what they already do, but it provides an additional perspective. After suggesting that the student try inferencing, the next step (as can be seen from figure 4.20) is to offer resourcing, or the strategies in ASKING/DISCUSSING (i.e. questioning and cooperation). This student already uses questioning, therefore the system offers only resourcing and cooperation. The student selects to attempt more resourcing.

30 By offering this additional information the student is also *cooperating* with the system (despite having vetoed the system's initial choice. The student's action here was valid, as shown in his explanation.) The system's record of the student's cooperation will therefore be incremented.

4.4.6 Evaluation of the Learning Strategies Component of Mr. Collins

Implementation issues

Section 2.4.4 concluded with a list of language learning strategies which could be usefully implemented in an ICALL system dealing with learning strategies. The feasibility of the implementation of these strategies has been demonstrated in section 4.4.3, where the system's strategy tracing mechanisms were presented. An example of the type of information which learners may obtain about their strategy use, based on the system's tracing of strategies, was provided, as were examples based on the initial learner profile. Section 4.4.1 included descriptions of how learners may use these strategies in Mr. Collins.

Section 2.4.4 also suggested that a reasonable mechanism should be found to decide the order in which learning strategies are introduced to students. Such a mechanism, based partly on a principle of 'ease of introduction and comprehension' depending on strategies already used, and also based on learners' previous reactions to language learning situations, has been implemented. This was described in section 4.4.1, and illustrated in figure 4.17 (for the ease of introduction/comprehension component). Section 4.4.4 provided further descriptions. However, it is not claimed that this is the best method; further, longer term evaluation is necessary to satisfy this question. What *has* been demonstrated is that this type of implementation is *possible*.

Finally, an example of learner/system discussion of learning strategies was presented in section 4.4.5, in order to demonstrate that the student may also offer his point of view about which strategies may be useful for him. This is in answer to the question posed in section 2.4.4, of the need to take account of the student's feelings and preferences about learning strategy use.

It should be noted that in this system, although learning strategies can be presented and discussed, there is no attempt to *directly* teach the use of learning strategies. This may not always be desirable, and is an issue for further research. Also, in section 2.4.4 it was stated that learners should be made aware of alternative beliefs about how to learn a language. This has been attempted implicitly, as such beliefs are likely to be affected by information about different approaches to

learning, in the form of descriptions of various learning strategies. However there is no explicit description of different beliefs. This issue needs to be investigated further. If beliefs about learning could be handled effectively, this would clearly be useful. However, the present approach of discussing *strategies* may be sufficient to influence beliefs about the range of ways to learn a language.

Student reactions

STUDY 4 (part 2)

It was necessary to evaluate the learning strategies component of the learner profile at an early stage because although it is possible that learning strategies can influence the acquisition of a foreign language, and that learning strategies can be dealt with from a learner modelling perspective, it was not clear whether students would welcome this type of approach in an ICALL system. The learner profile was therefore evaluated early in the development process, using students with varying degrees of experience in language learning, and with different learning strategy preferences. The aim was to assess whether students with differing language backgrounds, and who use different learning strategies vary in their attitudes to a system which explicitly refers to their learning strategies[31].

Method

Sixteen students were involved in the evaluation, selected on the basis of their different backgrounds in foreign language learning. The learners were divided fairly equally between those who studied a foreign language for their work (6), those who learn a language for its own sake (6), and those who study a language solely because it is a compulsory component of another course (4).

Oxford's Strategy Inventory for Language Learning (SILL - version 5.1, Oxford, 1990) was used in order to obtain sufficiently detailed information about each learner's current approaches to foreign language learning. The SILL questionnaire lists 80 statements of strategy use (e.g. number 1: 'I create associations between new material and what I already know'), with learner

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31 The transfer component of the learner profile was evaluated with the same students, at the same time. This was introduced in section 4.2.5.

response on a scale of 1 to 5, to indicate how strongly each statement applies to the student's own approach to learning. Oxford's SILL covers a range of strategies beyond those included in the ICALL system, however it is necessary to examine this greater scope in order to assess the likely attitudes to the system of all potential users.

After completing the SILL questionnaire students were introduced to the ICALL system, then were left to work with the system individually to cooperate in the construction of the learner profile (see section 4.4.2).

The next stage of the evaluation was the assessment of these learners' reactions to this initial interaction. A series of questions was specified addressing learners' language backgrounds and attitudes to the system. A short structured interview based on these questions was conducted, with the interviewer completing the questionnaire during the course of the interview.

The SILL questionnaires were analysed to determine the range and number of strategies recorded by each student, and the interview questionnaires were analysed in order to discover learners' language backgrounds (i.e. range of languages and proficiency). Student attitudes to the system's explicit reference to learning strategies were analysed and recorded.

Results

The learning strategies used by the students (as revealed by Oxford's SILL questionnaire) followed no clear trend with respect to the learners' reasons for foreign language learning. The overall range of the number of strategies used varied from the low/medium boundary, through medium, to three cases of high incidences of strategy use. (These three cases came one from a student taking language as a compulsory subject, and two from students learning a language for their work.)

The degree of proficiency in the students' most fluent foreign language varied. Those students learning the language for their work ranged from advanced to nearly fluent, while those following a compulsory language course were mainly intermediate. Learners learning a language for its own sake ranged from beginner

to nearly fluent. Relative experience in language learning did not appear to influence the quantity or type of learning strategies used (neither within the above sub-groups, nor across the whole group).

The only obvious difference in strategy use observed was that the three learners classed as having a broad range of strategies also used a relatively greater number of metacognitive strategies (particularly self-management, planning, directed attention, problem identification and self-evaluation). However, the reverse was not true, i.e. learners with a narrower variety of strategies did not necessarily use a particularly small selection of metacognitive strategies.

13 of the 16 students found the subject of language learning strategies interesting, while 3 did not. However, all students would be prepared to try to change their strategy usage if there were more efficient alternatives (even those who did not consider the subject of learning strategies to be interesting).

Conclusion

The results indicate no difference in attitudes to the system's discussion of learning strategies by learners with different language backgrounds, proficiencies and different learning strategies. The importance of this is that the system's approach depends on consistent attitudes throughout learner development, and also across the range of students. Further, this uniform reaction was positive - a crucial result as high levels of motivation and positive attitudes are necessary for cooperation.

Based on this small-scale evaluation of the learner profile and system aims it is suggested that learners with differing levels of experience in language learning, and different approaches to learning will in general react in a positive manner to the system's explicit reference to learning strategies. Students can therefore be expected to cooperate with the system to provide more information on these issues, such interaction in turn fostering further reflection on learning strategy use.

STUDY 5

A separate small investigation of 20 first year undergraduate students' approaches to the completion of a specific (pen and paper) short Portuguese multiple choice exercise on pronoun placement - i.e. they were asked to write down *what they did* while completing the exercise - indicated widespread unprompted use of the following strategies:

resourcing;
studying material prior to attempting exercise;
guessing;
checking work both during and after task completion.

The fact that students use various learning strategies even for short exercises justifies their inclusion in the system and representation in the student model. (We have already seen that the 16 students who took the SILL evaluation were without exception interested in improving their use of learning strategies, even those students who were not particularly interested in learning strategies as a topic in itself.)

4.4.7 Summary

Section 4.4 has described how the learning strategies handled are implemented in the system to enable it to understand what strategies a student uses, and it has also provided examples of the type of information available to the user. This information is both general information about language learning strategies, and student specific information about the types of strategy used by the student, and appropriate strategies for a particular student to try. An example of user/system discussion of strategy use was also provided to demonstrate that the system not only relies on its own knowledge of 'good strategies' and strategies which 'ought to fit' a student based on that student's current strategy use, but that it also takes account of how the learner feels about the different strategies.

The interactive learning strategy component of the system is activated only if the student specifically requests interaction on the subject, or if he is performing badly, and could benefit from increased use of a strategy from his repertoire or from a new strategy that could be easily adopted taking into account those already used. The

remainder of the time the system simply traces the learning strategies used by a student, to use this information later, when appropriate.

4.5 Language Awareness

As already described in section 2.5, the term *language awareness* may be used to refer to a variety of objects of awareness in language. In this thesis the focus is on consciousness of forms and patterns in language, with an additional consideration of knowledge about language transfer, acquisition sequence and language learning strategies. Our discussion of language awareness is therefore related to the issues introduced previously.

The target domain has already been described in section 4.1. The focus in that section was on error types produced by students, however such a description must necessarily be compared to the correct target language forms. Therefore the content of the domain and potential errors will not be detailed again here. As stated above, in addition to awareness of language form we are also considering awareness of factors which may influence language learning. Examples of such issues were presented in sections 4.2 - 4.4. The purpose of this section is to relate the issues introduced previously to the concept of language awareness. However, the topic of awareness and the role of Mr. Collins will not be developed fully until section 4.6 (though the theme of section 4.6 will be anticipated). A quick reminder of the main language task is presented below.

Most exercises in the system take the form of Portuguese sentences offered to the student, with the object pronoun missing. The desired pronoun is provided separately, and students are instructed to place this in the correct position in the sentence, as in the example below:

System: Please place the pronoun 'lhes' correctly in:
Não disse nada.
Student: Não lhes disse nada.[32]

32 'He did not tell them anything.'

'Não disse nada' appears in an edit field, which can be amended by the student as he believes appropriate.

In cases where the third person direct object pronoun (*o, a, os, as*) follows the verb, if the verb form ends in *r, s* or *z*, phonetic contractions are required. The final *r, s* or *z* is omitted and *l* is affixed to the front of the pronoun (--> *lo, la, los, las*). In addition, when the stress is on the final syllable, or the verb form consists of only one syllable, a written accent is usually required. A similar change occurs after verb forms ending in a nasal sound; third person direct object pronouns become *no, na, nos, nas*. However the final nasal sound is not omitted. A more complicated example is therefore:

System: Please place the pronoun 'a' correctly in:

Neste caso venderia.

Student: Neste caso vendê-la-ia.[33]

In the conditional tense, as in the above example, in cases where a pronoun would usually be post-verbal it must instead become an infix between the infinitive stem and the conditional ending. *Vender* ends in *r*, which must therefore be dropped, an accent must be added to the *e*, and *l* must be prefixed to the pronoun *a*.

Awareness of language form implies awareness of explicit rules, though availability of rules alone may not be sufficient to induce language awareness. In section 2.5 it was shown that many language learning systems include explicit treatment of grammatical rules. This is also true in our case. The rules of pronoun placement can be accessed (as illustrated previously in figure 4.15), and can also be presented in conjunction with examples. Other rules can also be viewed, for example, the rules of phonetic contraction as presented to the student in figure 4.22. (This information has already been provided above, and in section 4.1.1 in order to explain phonetic contractions to the reader.)

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33 'In that case I would sell it.'

PHONETIC CONTRACTIONS

These occur with some post-verbal pronouns

1. If the verb form ends in:	r, s, z	
and the pronoun is:	o, a, os, as	
		r, s, z is omitted
		l is attached to the front of the pronoun
		(lo, la, los, las)
2. If the verb form ends in:	a nasal sound	
		n is attached to the front of the pronoun
		(no, na, nos, nas)
		(The final nasal sound is NOT omitted)
3. Before:	reflexive nos	
		final s is omitted

4. Tens + o ALWAYS becomes:

tem-lo

Figure 4.22: rules for phonetic contractions

Therefore the ICALL system, in addition to providing opportunity for practice in the traditional sense, seeks to enhance learner awareness of language in that all rules of pronoun placement are made explicit, as are the phonetic changes often required. Moreover, the student's use of these rules may also become the object of discussion between the student and system; an additional source for the development of learner awareness (see section 4.6), which does not tend to be provided in other language learning systems promoting the use of explicit rules.

Unlike the other issues described in chapter 4, language awareness is not represented in the student model itself. It should occur as a direct result of the openness of the model (and the system in general). Figure 4.23 below shows the integration of language awareness into the architecture housing the previous issues of this chapter:

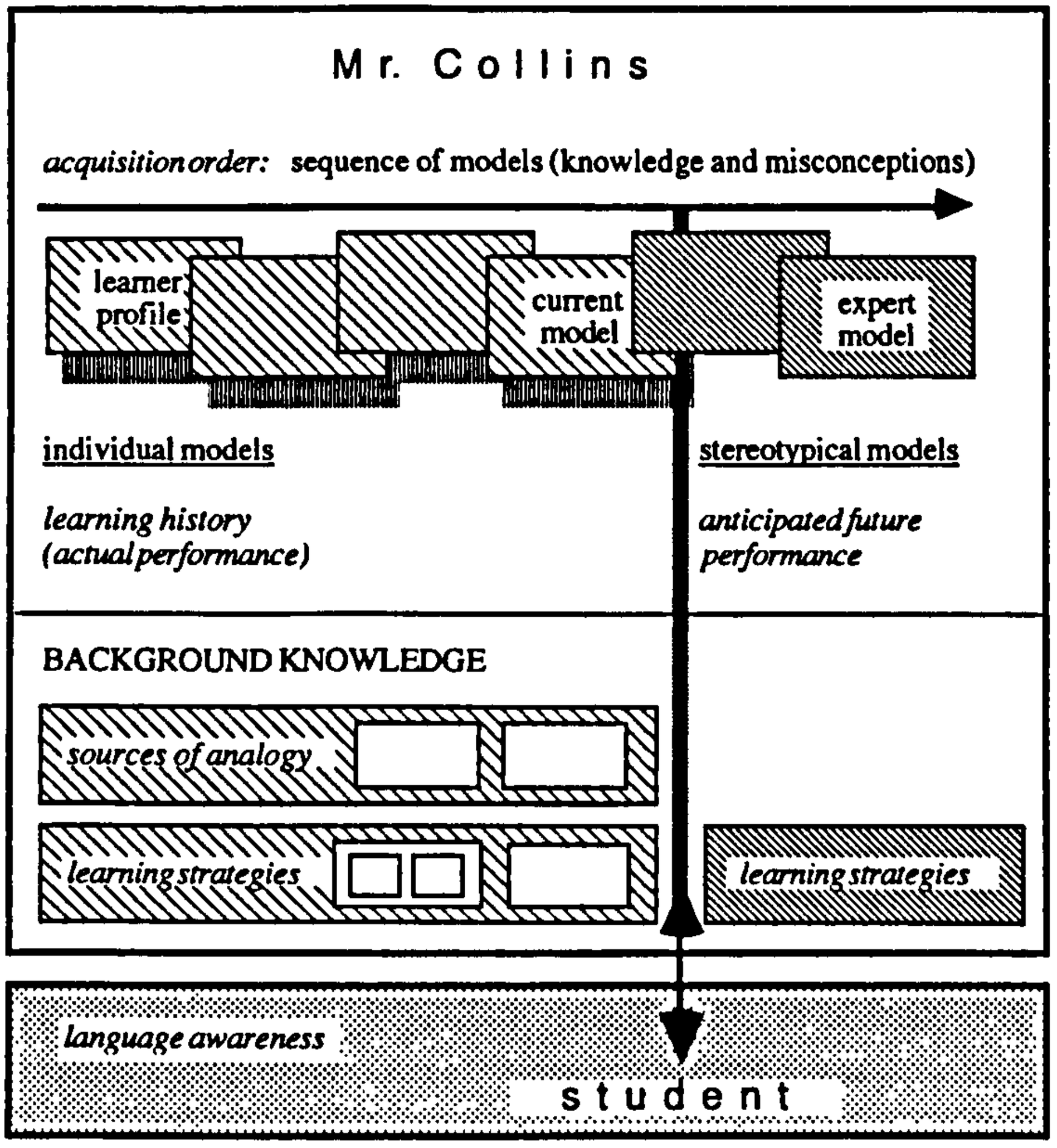

Figure 4.23: promotion of language awareness through Mr. Collins

The notion of acquisition sequence and the way in which this has been used in the student model has already been described in sections 2.4 and 4.4. The student may view the contents of these different models. In some cases the information obtained from such model inspection will be the same as that received from

consultation of other sources. An example of such a situation is learner inspection of the *expert model*, the contents of which are the rules (and examples) of the target domain knowledge. Thus the information is identical to that received through the resourcing option (under learning strategies), about the target grammar (see section 4.4.1).

On the other extreme of the student model continuum is the *learner profile*. This is likely to be of less interest to the student unless he is new to the system, though it may be useful for the learner to compare information in the current model to the initial information in the learner profile, as a reminder of how much he has actually learnt since he started using the system. Acquisition of information for the learner profile about background languages has been described in section 4.2.2, and for learning strategies in section 4.4.2. In the case of the learner's initial proficiency in pronoun placement in Portuguese the procedure is similar, however instead of the system asking learners about their knowledge, they must take a short test. In this test Portuguese example sentences are introduced in pairs in order that the learner may select which of the two presented is correct (for example, a. *Não compra-os*, b. *Não os compra.*) The learner is also allowed the option 'don't know'. Examples based on each of the rules assigned a position in the acquisition order described in section 4.3.1, are presented in this manner. This enables the system to estimate the learner's most probable initial position on the student model continuum. The learner is also asked about his degree of certainty regarding his choice of answer, in order to obtain his initial belief measure (see section 4.6). The system's belief measure is based on the student's actual performance (again, see section 4.6). The type of information received on inspection of the learner profile with regard to proficiency is as shown in the example in figure 4.24 below.

There are 12 rules of Portuguese clitic pronoun placement dealt with by this system. These are divided into 8 different levels. You are on level 2, which means that you probably know 4 of the 12 rules - those in:

negative clauses	e.g. Não os compra.
open questions	e.g. Quem os compra?
affirmative main clauses	e.g. Compra-os.
positive imperatives	e.g. Compra-os!

You are less likely to know rules for the following:

infinitives	e.g. Quer comprá-los.
some adverbial phrases	e.g. Também os compra.
relative clauses	e.g. Vejo o homem que os compra.
subordinate clauses	e.g. Sei porque os compra.
auxiliary and past participle	e.g. Tem-nos comprado.
yes/no questions	e.g. Compra-os?
future tense	e.g. Comprá-los-á.
conditional tense	e.g. Comprá-los-ia.

Figure 4.24: example of proficiency information deduced from the learner profile

The information available about proficiency level in the learner profile is very limited, as it is drawn from only the initial test (which may not always prove to be reliable data). However, as this information is used by the system until further data becomes available, it is also inspectable by the student.

The learner may also view intermediate stages, i.e. the learner history between the initial profile and current model, and anticipated progression between the current model and expert model. However, the information available here is currently limited to the route learners followed in their acquisition, and their expected future progression, with no indication of other questions such as the timing between the acquisition of successive rules, etc.

The main object of inspection and facilitator of language awareness in the student model continuum is intended to be the *current model*. This is the part of the student model common to all student models: the information about the learner's current state of knowledge. However, although it contains the usual information the model is unusual in its focus of externalising its contents[34] to the student, to try to prompt him into thinking more about his knowledge (and misconceptions) of the target language domain. The type of information available to viewing is as in figure 4.25:

34 See Paiva et al (1995) for a more general discussion of externalising student models. (Mr. Collins is a detailed example of one of the uses suggested for an externalised student model.)

So far this session you have attempted 13 NEGATIVE sentences.

Your total number of correct sentences with this structure is: 9.

From your recent performance the system believes you to have a perfect command of the rule used in NEGATIVE CLAUSES.

So far this session you have attempted 5 sentences with a DECLARATIVE VERB-PRONOUN structure.

Your total number of correct sentences with this structure is: 2.

From your recent performance the system believes you to have a somewhat shaky knowledge of the rule for AFFIRMATIVE MAIN CLAUSE STATEMENTS.

	YOUR CONFIDENCE: (a - d)	SYSTEM CONFIDENCE: (1 - 4)
The pronoun is:		
pre-verbal in negatives e.g. Não os compra	• unsure (c)	• very sure (1)
post-verbal in positive main clauses e.g. Compra-os	• almost sure (b)	• unsure (3)

Figure 4.25: example of proficiency information deduced from the current model

If a learner chooses to inspect the student model (either after prompting, or on his own initiative), statistical information is provided about his *overall performance* for each rule attempted. He is also given a summary of his *recent performance* which is based on his last five attempts to use a rule. This is in order that assessment does not depend only on the very last attempt, but nor may it be influenced by earlier attempts which may no longer be valid. This information is retrieved from the student model and presented via text templates in order to make it accessible to the student. If the student wishes to investigate further, learner and system confidence measures for each rule are also displayed. In the above illustration of a learner who has attempted pronoun placement in negative sentences and in affirmative main clause statements, it is indicated that the system is very sure that the student knows the rule for pronoun placement in negative clauses, but the student himself is unsure. The system is unsure that the student knows the rule for the positioning of pronouns in affirmative main clauses, but the student is more confident (almost sure). As with the summary of the learner's performance, the

confidence levels are also based on a learner's last five attempts to use a rule, i.e. the learner's most recent five statements of confidence associated with sentences using a particular rule will be 'averaged' to determine his confidence in using this rule, and his actual performance over his last five attempts at the same rule will determine the system's confidence in his use of the rule (see Bull, 1994). This is not detailed further here, as the actual mechanisms of the student modelling process are not relevant: Mr. Collins can be used in combination with any (successful) student modelling approach. The confidence values are on a four point scale (very sure/almost sure/unsure/very unsure). The learner's confidence is indicated by the values a - d ('a' being the highest level), and the system's confidence in the student by 1 - 4 ('1' portraying the highest level of confidence).

In the above example, the two confidence measures for negative sentences are incompatible - the learner has low confidence (c) in his knowledge of the rule, but his performance leads the system to be very confident (1) in his use of this rule. For positive main clause statements, although the belief values differ (3 and b), they are still close enough to be compatible (a step down for the system, or a step up for the student - i.e. 4b or 3a would be necessary before the values became incompatible). The aim is that through discussion, the values should become identical (1a, 2b, 3c or 4d), or at least within one value on the scale. This will not only result in a student model which is more faithful to the true situation (as the student may have information which the system alone cannot take account of), but will also encourage the student to reflect on his learning, thereby also contributing to his learning (ultimately resulting in increased student and system confidence measures). Figure 4.25 is simply an example of information presented to a student. As stated above, language awareness is further promoted by allowing the student to discuss this information, and indicate his disagreement in cases where he believes it to be unrepresentative. This is discussed fully in section 4.6. For the present it suffices to claim that explicit indication of (possibly conflicting) student/system belief measures is designed to encourage the learner to think about his learning, and become more aware of the language and his learning. Of course, more than this is required, and will be presented later.

The above descriptions have focussed on inspection in relation to the acquisition sequence. Thus as well as helping learners develop an awareness of the rules and form of the target domain, the term language awareness includes an

awareness of the notion of a *process* or *evolution* of learning. The learner can see from the student model continuum that learning is not expected to occur without error. In addition to correct rules and performance students are also able to review the errors they have made, as indicated by the shadows behind the individual models in figure 4.23.

The notion of language awareness is not restricted to the target language rules, performance and sequence of acquisition of these rules, but can also refer to other issues connected with language considered in Mr. Collins. For example, the learner is encouraged to explore the area of language transfer, in relation to the languages he knows. He may access explicit descriptions of the corresponding rules of other languages, each of which is represented separately in the system (see section 4.2). Another area about which the learner's awareness may be raised is the use of learning strategies. The learner may view information in the student model about his own use of strategies (which, as indicated in figure 4.23, may be about individual strategies or groups of similar strategies), or he may consult more general information about language learning strategies. The type of information available therefore comprises descriptions of different strategies, and statements about individuals' use of strategies and the implications of using particular strategy groupings. This information has been provided in section 4.4.

In this section a brief overview of the information available in the system to prompt greater awareness has been given. The discussion of this topic is not yet complete; the purpose of this section was to integrate the themes of Mr. Collins that were presented previously, and show their relationship to the issue of language awareness. However, language awareness itself is developed to a greater level, through the idea of promoting reflection by learner/system discussion and negotiation. We turn to this now, in section 4.6. The discussion becomes more general as the notion of collaborative student modelling to be presented does not apply only to language learning, however in the context of language this can be seen to be closely linked to the issue of language awareness.

4.6 Collaborative Maintenance of Mr. Collins

In this, the last section of this chapter, we move on from the consideration of language issues to *collaborative student modelling* as implemented in Mr. Collins. As stated previously, these two topics are linked, however the following discussion will become more general as we move away from SLA as the focal point. The examples will, of course, still be in the area of Portuguese pronouns, but the methods employed here are anticipated to be relevant also to other domains (see Bull et al, 1995).

Section 3.2 proposed a student model with parallel belief measures representing the student's beliefs and the system's beliefs about the student as a starting point for negotiation. In order to discuss beliefs sensibly, to jointly maintain the student model, the system must have a knowledge of the student's real beliefs with which to compare its own inferences about these beliefs. This will also require the learner to state his degree of confidence. This statement of confidence may also help students to clarify their position to themselves before engaging in a dialogue with the system, aimed at defending their beliefs. Section 3.2 concluded with the assertion that students must be able to understand the process, as well as use it, if collaborative student modelling is to be successful. They should also be willing to revise their beliefs when confronted with new information. The relationship between students' levels of confidence and their willingness to alter their beliefs needs to be investigated.

Section 4.6.1 investigates what people understand by 'negotiation'. In section 4.6.2 an empirical study is introduced, to support the use of student-provided *belief* or *confidence measures*[35] in student modelling. Section 4.6.3 describes how students may inspect their student model; section 4.6.4 describes the process by which they may change the representations of their beliefs; and 4.6.5 illustrates how students may challenge the beliefs of the system. In section 4.6.6, a study to determine whether students do in fact inspect and challenge the student model is presented. Finally, section 4.6.7 describes informally, the notion of negotiation as it occurs in the system.

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35 These terms are used synonymously.

4.6.1 What is Negotiation?

As stated in section 3.2, negotiation will here not be continuous; it occurs only if there is some inconsistency between the learner's and system's beliefs about the student's knowledge, or if either agent initiates discussion about learning strategies. The approach chosen, therefore, is that of *targeted negotiation* (Bull & Smith, 1995)[36]. For a description of some of the features of targeted negotiation used in this context see section 4.6.7.

For the purposes of Mr. Collins it is not important to understand a dictionary or other formal definition of the term negotiation; the crucial issue is *what users understand* by the term. Thus, in STUDY 6 several potential users were asked to write their own definition of 'negotiation', then to come together with another subject who had also written a definition, and decide on an agreed definition after considering both alternatives. Additional single definitions were also received. Subjects varied slightly in the detail of definitions offered, though there appeared to be general agreement about what negotiation entails: discussion to reach a generally acceptable conclusion. The main difference was that some subjects viewed negotiation as something which occurs in a negative context, i.e. where there is disagreement, while others did not mention this aspect. It appears therefore, that the common notion of 'negotiation' fits the definition to be used in Mr. Collins (The definitions received are reproduced in appendix F.) Therefore, while having to explain to users that they may negotiate with the system, it should not be necessary to explain what negotiation is, in this context.

4.6.2 Can Students State their Confidence in their Answers? Are they Right?

Section 3.2 called for a study to investigate the following:

- whether students are willing and able to state their beliefs;
- identify students' levels of confidence in their answers;
- assess their willingness to alter answers if their beliefs are challenged;

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36 E.g. in this system the domain is not negotiable, but the contents of the current version of the student model are. Negotiation is therefore targeted at the current student model.

- identify if there is a relationship between the strength of a student's belief and willingness to alter it.

This study is described below.

STUDY 7

Task

Thirteen of the 47 students in the main study (1) took part in study 7. These learners were volunteers who chose to take a (pre-exam) revision test. Each subject received the same 25 questions in a different random order. Their task was to place the pronoun into the correct position in the sentence, also making appropriate phonetic contractions where necessary. They then indicated their level of confidence in their answer on a four-point scale. The questions were presented as in the following example (the full set of questions is given in appendix Bii):

Please rewrite this sentence placing the pronoun in brackets into the correct position:

Não tenho comigo. ***(os)***

How confident are you about your answer?

Please tick appropriate box:

very sure	almost sure	unsure	very unsure

Students completed the exercise at their own pace, with optional reference to grammar notes. They were then provided with a list of explicit rules and accompanying example sentences relating to pronoun placement, before receiving feedback as to the correctness of their answers (for the full set of rules and examples used see appendix Biii). For example, the rule and example corresponding to the question above is:

The pronoun is pre-verbal in negative clauses. **(e.g. Não os compra.)**

Thus the correct version of *Não tenho comigo (os)* is: *Não os tenho comigo.* (I don't have them with me.) After considering this information students were told that they could change any of their original answers. They were also requested to indicate which rule/example prompted them to alter their sentence. This study provided information on how confident students were in their answers; the frequency with which they were willing to change their beliefs (to correct previously incorrect answers); and whether the degree of initial learner confidence affects their willingness to negotiate 'incorrect' beliefs.

Results

Of the four levels of confidence provided for students to use, 7 used all 4 levels offered; 3 used 3 levels, and only 1 student discriminated between only 2 measures of belief. The use of different levels varied across the full range of four values, though the lowest level was used least frequently.

It was found that 50% of sentences with incorrect placement of the pronoun were revised. Four students made no revisions despite having between four and nine (out of 25) sentences wrong. Considering the 8 students who did make revisions to incorrect sentences, the total number of errors made averaged 7.9 per student. The number of sentences left with placement errors by the 4 students who made no revisions averaged 5.8 per student. No learner moved a correctly placed pronoun to an incorrect position. So, two thirds of students did make revisions to half of their incorrect sentences. Those students who made no revisions also tended to make fewer errors than those who did change their answers, (though this figure is not significant). This suggests that the majority of students are prepared to revise some of their answers as a result of receiving new information, even when this additional information is not explicitly associated with a particular sentence or error. (It should be noted that as the students were not told which answers were incorrect, they might be less motivated to make changes than perhaps if they had received fuller feedback on their responses.)

In looking at the students who did revise answers, we consider if there is any clear relationship between the level of confidence they hold in their answers and their willingness to alter them. Data for the 8 students is presented here. For each student, S1 to S8, the number of sentences with errors in is given, classified by the

level of confidence in the answer (A to D: A = very sure; D = very unsure). Sentences where changes were made, and those where none were made are given separately. Totals are given by each confidence level and each student.

	Where changes were made to sentences:					*Where no changes were made to sentences:*				
confidence level:	A	B	C	D	total	A	B	C	D	total
subjects:										
S1	0	1	1	0	2	0	1	1	2	4
S2	0	1	3	0	4	0	0	0	1	1
S3	1	1	2	0	4	0	0	4	1	5
S4	0	2	1	1	4	0	0	3	1	4
S5	0	0	4	0	4	0	4	1	0	5
S6	1	1	2	1	5	2	1	1	0	4
S7	1	2	2	0	5	0	2	2	0	4
S8	1	1	0	2	4	2	0	1	1	4
totals:	4	9	15	4	32	4	8	13	6	31

There are similar patterns to the data in the two groups of sentences: in both cases the average number of sentences with errors occurring increases initially as confidence decreases, then decreases at the lowest level of confidence. It should be noted that, as this was the level used least frequently, it is hard to assess what this change in the direction of the trend suggests. If level D were ignored, the general trend could be taken to indicate that decreasing confidence in answers often accompanies increasing frequency of errors: this would make sense. However, as both sets of data show similar patterns, confidence cannot be said to influence whether learners are prepared to alter their answers if confronted with new information.

Turning to the four learners who made no alterations to incorrect sentences, the following data was obtained:

No changes were made to sentences:

confidence level:	A	B	C	D	total
subjects:					
S9	1	6	1	0	9*
S10	0	1	3	0	4
S11	2	1	1	0	4
S12	0	4	1	1	6
totals:	3	12	6	1	23*

* For one answer, no confidence level was provided.

The pattern for these learners was slightly different; they tended to be a little more confident in their answers. This could indicate that the higher degree of confidence of these learners leads them to believe that there is no need for them to reconsider their answers. However, this is only suggestive evidence.

Conclusion

Whilst the data collected in this study[37] is based upon a small sample size, the results indicate that the system's use of belief measures on which to base discussion with the student is plausible, because

1. learners have been shown to be able to state their degree of confidence;
2. they will in general be prepared to revise their beliefs regardless of their initial conviction about their answer.

It is believed that this approach will enable students to successfully negotiate their own student model.

STUDY 8

Subsequent to the revision test, each learner was sent a questionnaire asking their reasons for giving certain (incorrect) answers. Four questionnaires were

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37 Study 7 was designed and carried out by Susan Bull; the analysis of data in the results section of study 7 was performed jointly by Susan Bull and Helen Pain.

returned (see appendix Bv). In these four cases it is clear that learners can answer externally posed questions about why they made a particular choice. Where they were unsure they were able to state this fact, and sometimes also offer a possible explanation. This indicates that at least some learners will be able and willing to answer the system's questions about their input, when it is attempting to disambiguate potential alternative representations for the student model. This is further illustrated by the following from the questionnaire responses. All four learners experienced difficulty with the placement of the pronoun in the conditional tense. One of the test questions was:

O Manuel e o seu filho diriam mais tarde (lho).
(Manuel and his son would tell it to them later.)

The correct answer is:

O Manuel e o seu filho dir-lho-iam mais tarde.

The pronoun *(lho)* becomes an infix between the infinitive stem *(dir)* and verb ending *(iam)*. Three of the four learners wrote: **O Manuel e o seu filho <u>diriam-lho</u> mais tarde*, and one: **O Manuel e o seu filho <u>diria-lho</u> mais tarde* (this latter error of omission of 'm' occurred as a result of the inappropriate overgeneralisation of another Portuguese rule, and is not discussed further here. For the purpose of this argument the four responses will be treated as identical.)

In an affirmative main clause statement the pronoun is usually post-verbal, however, in the conditional (and future) tense, a pronoun which would normally occur post-verbally becomes an infix. The above error could have had more than one cause; it is not possible to infer the learners' beliefs simply by looking at their answers. All four placed the pronoun after the verb. The error made by these learners could be a result of overgeneralisation of the rule usually applicable in main clause statements, or they may not have realised that *diriam* is a conditional form. In these four cases, when asked by questionnaire, one learner specifically believed that in conditional main clause statements the pronoun follows the verb. Two learners stated that they did *not* believe this to be true, and the fourth did not know. Only the first learner realised that *diriam* is a conditional form; it is therefore clear that the second and third learners did not make this error for the same reason as the

first. (Had they realised that the sentence was conditional, they would presumably have completed it correctly.)

On recognising an error such as the above, a conventional system would probably try to infer the learner's misconception by setting further test questions in order to work out what the student believes (e.g. IDEBUGGY - Burton, 1982). The questionnaire responses indicate that at least some students are able to answer questions of the type: Did you believe A, or did you believe B? In the first three cases above, asking the students provided useful information about their beliefs. Even where learners are unsure, the posing of the question will at least have prompted them to reflect on the issue, and they may be able to discount some alternatives even if some ambiguity remains. (The fourth learner, although unsure as to his beliefs about the positioning of the pronoun in conditional sentences, did state that he had assumed the rule applicable in affirmative main clause statements to be appropriate.) Therefore, Mr. Collins uses this technique of asking the student directly, when it is unsure.

4.6.3 Inspecting Mr. Collins

As suggested in section 3.2, negotiation in Mr. Collins occurs through menu format. This enables easy indication to the student of possible alternatives which he may not otherwise have considered or realised were available. Discussion may be initiated by either agent. Inspection of Mr. Collins has already been detailed in section 4.5. Part of figure 4.25 is reproduced here for convenience, as figure 4.26. For the full explanation the reader should refer back to section 4.5.

	YOUR CONFIDENCE: (a - d)	SYSTEM CONFIDENCE: (1 - 4)
The pronoun is:		
pre-verbal in negauves	• unsure (c)	• very sure (1)
e.g. Não os compra		
post-verbal in positive main clauses	• almost sure (b)	• unsure (3)
e.g. Compra-os		

Figure 4.26: inspecting current proficiency

The student and system belief measures could be viewed as similar to the outside boundaries in bounded student modelling (Elsom-Cook, 1986; 1988); i.e. the 'true' representation of the student is likely to be anywhere within the area defined by the two measures. The difference is that in collaborative student modelling the aim is to reduce the area through negotiation.

4.6.4 Changing the Student's Beliefs

If, after viewing information in the student model, the student disagrees with either his own confidence level, or that of the system, he may select the option allowing the possibility of changing the model. If he chooses to alter his own confidence measure he is asked what level he wishes to change this to. If the new value exactly matches that of the system, the system acknowledges that it agrees with the choice. If it almost matches (as in the above example for main clause statements), the system will indicate that there is a difference between their two confidence measures (here that the system is a little less confident), but it will acknowledge that this difference is not great enough to be incompatible. If the student were to change his confidence measure to a value which is very different from that of the system (in this example where the system is 'unsure (3)', if the student were to select 'very sure (a)'), the system would state that the two belief measures were not compatible, and ask the student if he wishes to ignore this incompatibility, and maintain his new selection. The student may insist on his own choice, or may ask the system to justify itself, and then may or may not be

convinced by the system's reasons. System justification involves presentation of the student's sentences, together with an assessment of his performance. Below is an example showing part of a test session with the system to illustrate a student changing his own confidence measure to one which is incompatible with that of the system.

---

system:

Currently your own confidence in your use of the rule applicable in positive main clause statements is:

almost sure / b. (system's confidence = unsure / 3)

What is your new confidence level?:

- very sure (a)
- unsure (c)
- very unsure (d)
- (cancel)

student: (selects)

very sure (a).

system:

You have changed your confidence measure from 'b' to 'a'. This new confidence value is a lot higher than that of the system; the two confidence measures are incompatible. Your last five attempts to place the pronoun in positive main clause statements were the following:

* O Manuel a mostrou no mapa.
* O Manuel mostrou a no mapa.

  O Manuel mostrou-a no mapa.
* O homem o comeu rapidamente.

  O homem comeu-o rapidamente.

These recent attempts have demonstrated that you are still having some difficulties.

Confidence measure 'a' is too high for your actual proficiency. What do you wish to do?

- system justify itself
- change belief
- view student model
- keep new belief

Figure 4.27: changing the student's confidence

Up to this stage in the discussion of the student model, although the system has indicated which sentences contain an error through use of an asterisk, it has not indicated which type of error is involved. This is because this part of the interaction is concerned with the level of confidence in the correctness of a rule, rather than an attempt to overcome a particular problem (though through increased reflection, this may also lead the student to realise his mistakes). The system will explain errors at this point only if the student requests a justification of its assessment of his performance. Alternatively the student may select to once again inspect the contents of the model in order to reconsider before making a final decision. The student may decide (immediately, or after inspection of the model, or justification from the system) that the alteration of his own confidence (here from 'b' to 'a') was inappropriate, and may decide to change it back (to 'b') or select another alternative ('c' or 'd'). A final option available to the student is to insist on maintaining his new confidence value, an option to which he is entitled, as it is, after all, his own belief. The student is not required to justify his decision here in order to allow the discussion to come to an end. The student will only have to justify himself if he is trying to alter the system's confidence measure (see below).

4.6.5 Challenging Mr. Collins

If the student disagrees with the system's level of confidence in his performance, he may challenge the system in an attempt to make it alter its own representation in the student model. However, if then requested, the student must be willing to defend his beliefs explicitly. If he is unable to convince the system it will maintain its own original confidence measure.

On challenging the system, the student is first asked whether he is happy with the representation of *his own* confidence measure (as the system must be sure of the student's current views in order to know what it is defending itself against). The student is then asked what he feels the system's confidence in his ability should be changed to. An example attempt at changing the system's beliefs (again for affirmative main clause statements) follows.

system:

The system's confidence in *your use* of the rule for positive main clauses is currently: unsure / 3.

What do you believe the system's confidence should be?

- very sure (1)
- almost sure (2)
- very unsure (4)
- (cancel)

student: (selects)

very sure (1).

system:

Your choice of '1' is very different from the system's own assessment. What do you wish to do?

- accept system's decision
- accept compromise (2)
- system justify itself
- justify myself
- view student model

student: (selects)

system justify itself.

system:

You are trying to change the system's confidence measure from '3' to '1'.

This new confidence value is too high.

Your last five attempts to place the pronoun in positive main clause statements were the following:

* O Manuel a mostrou no mapa.
* O Manuel mostrou a no mapa.

  O Manuel mostrou-a no mapa.
* O homem o comeu rapidamente.

  O homem comeu-o rapidamente.

These recent attempts have demonstrated that you are still having some difficulties.

You have probable transfer from Spanish for pronoun placement twice.

You have omitted the hyphen once.

You actually have only two correct sentences in your last five attempts.

Figure 4.28: Challenging the system's beliefs

Because the student has selected a value for the system which is distant from the system's own view, the system will not automatically allow itself to be persuaded. The student is offered the option of simply accepting the system's decision without argument; of viewing the student model once more before making a decision; of accepting a compromise (here '2' is the mid-point between '1' and '3' - had the system's confidence in the student been at 'level 4', no such compromise would have been offered as the distance between '1' and '4' is too great); or of system or student justification of their standpoint. If the student requires the system to explain its position, the system will present the student's most recent five attempts, together with its reasons for its assessment, as in this example. The student may or may not be convinced, and is again offered the above choices for how to proceed. If the student chooses to justify himself to the system, he will be offered a test sentence. If he is able to demonstrate to the system that his own claims about his proficiency are right (in this case that he can use the rule correctly), the system will be convinced by his argument. In the following example the student is offered a test, and proves his argument by producing a correct sentence.

---

system:

Please place the pronoun 'a' into the correct position in the following sentence:

'O João confirmou.' (João confirmed / it)

student:

O João confirmou-a.

Figure 4.29: convincing the system

However, if the student is not able to demonstrate the validity of his claims (in this example if he had been unable to produce a correct sentence), the system will try to confirm the correctness of its own representation by generating an identical sentence to that produced by the student, but based on the representations it has constructed in the student model. For example, in this case the system could predict that the student may use Spanish word order, e.g. * *O João a confirmou.*

Similarly, using the student model the system could also predict that the learner may omit the hyphen with a correctly placed pronoun, e.g. * *O João confirmou a.* If the student had offered either of these sentences as their response to the system's test, the system would have been satisfied that its own representation was correct, and therefore would not have allowed the student to override it.

The following example is an interaction trace[38] of a student challenging the system's model.

18 . 8 . 1996
6.18pm

O Manuel os repara aqui (d)
Transfer from Spanish

QUESTION GRAMMAR
- rules
- aspects of transfer

VOLUNTEERED INFORMATION about difficulties
- I compare too much to other languages
system suggestion: Deduction and Inferencing

LEARNING STRATEGIES
- general information:
deduction

Compra-a aqui (c)

NOTES MADE

Este livro explica-o (b)

38 This is a trace of a hypothetical student, obtained from a test interaction with the system.

Ele limpa-os usando muito sabão (a)

Tenho-as às quintas (a)

QUESTION MODEL

::::::::::: main clause :::::::::::

challenge system's confidence

change system's confidence: 2 --> 1

(own confidence = a)

justify reasons: now understand

• tested correct - system confidence increases to: 1

Figure 4.30: trace of a challenge to the system

In this example the learner has first entered an incorrect sentence, and has indicated his lack of confidence in the attempt by choosing the lowest confidence value: D. (The error was diagnosed as a transfer error.) The student then decided to check the available information about the Portuguese rule and also the Spanish equivalent. At this point the learner shows his agreement by volunteering the information that he compares too much to other languages. The system suggests two strategies which may be useful, and the learner seeks further information about one of these. He then attempts a second sentence, and has a slightly higher degree of confidence. With subsequent correct input his confidence increases until it reaches the 'very sure' level (A). The student then decides to view the student model, and on seeing that his own confidence level is now A, and that of the system is 2, he chooses to challenge the system. (The system's confidence is 2 because one of the previous 5 sentences - the number taken into account (Bull, 1994) - was incorrect.) He tries to change the system's confidence from 2 to 1, but the system points out the discrepancy between the two levels. The student selects to justify his reasons, and when claiming that he now understands where he was previously having difficulty, the system states that it will only accept this if given proof. The student is offered a test sentence which he completes correctly, and the system increases its confidence in the student to 1, accordingly.

4.6.6 Do Students Inspect and Challenge Mr. Collins?

The student may or may not choose to inspect the student model. Although the system may try to prompt inspection, or specifically question the student about his knowledge and beliefs, the student is not obliged to react. Therefore a study was conducted to determine the answers to the following questions:

STUDY 9

1. would students inspect their own student model?
2. would they challenge the contents of the model in cases where they disagreed?
3. would they prefer
   a) no access to the model;
   b) access, but no power to change the contents of the model;
   c) access and power to change the model?
4. if 'c' above, would they prefer
   a) power to alter the model, but no challenge from the system;
   b) power to change the model with challenge from the system where it disagreed with changes?

Subjects

Nine adult beginners (i.e. learners with no previous knowledge of Portuguese) were involved in the study; five postgraduate students (group A: A1-A5), and four non-university educated adults (group B: B1-B4).

Method

Each learner was observed using the system in which the model was embedded. All actions were also automatically recorded by the system. Students were instructed to use the system as they wished, and were provided with a summary of menu options which they could use. The sessions lasted between thirty minutes and two hours, the length being determined by the learners themselves. A structured interview took place on completion of each session. The results presented below follow from analysis of these observations and interviews.

Results

All nine learners chose to view the student model. Six viewed the model after prompting from the system (A3, A5, all of group B); the remaining three students (A1, A2, A4) inspected the model without being prompted, as they felt appropriate. Five of the learners tried to change the representations in the model (A1, A2, A4, A5, B4). The remaining four learners were generally happy with the contents of the model (both student and system confidence measure) on the occasions on which they inspected it, and therefore felt there was no need to change anything. The following table shows each learner's actions in the student model: whether they changed their own confidence measure; whether they challenged the system's confidence measure; whether they would have changed their own confidence measure, or challenged the system's, had they disagreed with it (in cases where they were content with the representation in the model).

subject:	changed own confidence measure	would change own confidence measure	challenged system's confidence	would challenge system's confidence
A1	yes		yes	
A2	yes		no	yes
A3	no	?	no	yes
A4	no	?	yes	
A5	no	?	yes	
B1	no	yes	no	yes
B2	no	yes	no	yes
B3	no	yes	no	yes
B4	yes		yes	

Three learners made changes to their own confidence measures. Of the six who did not, three stated that they would have, if they had started to disagree with the representations in the model. Three learners were not asked whether they would have altered their own confidence measure in such a situation - though the fact that two did challenge the system, and the other learner would have, had the situation arisen, suggests that they probably would also change the representation of their own confidence if this were felt to be no longer true.

Four learners challenged the system's confidence in their performance. All five who made no such challenge stated that they would, if they (persistently or strongly) disagreed with the system's assessment.

<u>In a situation of conflict when challenging the system - what each subject did/would do:</u>

<u>*A1:</u> preferred the option of the system defending itself when in conflict. She would only try to justify her own beliefs if she very strongly disagreed with the system.

<u>°A2:</u> would normally choose to see the system's justification first, before justifying herself, but if she was very sure about her own assessment of the situation, she would try to justify herself first. She may also view the student model again. She would accept a compromise only as a last resort.

<u>°A3:</u> at first continued with more exercises, believing the system's assessment to be probably more reliable than her own views. If she had later still disagreed with the system she would have challenged it. She would prefer to view the system's justification first, and if unconvinced, would attempt to justify herself.

<u>*A4:</u> chose to justify himself, as he had high confidence in his own beliefs.

<u>*A5:</u> preferred the system to justify itself, and if still unconvinced she would offer her own reasons afterwards.

<u>°B1/B2/B3:</u> would first request the system to justify itself. If unconvinced they would then try to justify themselves, finally accepting a compromise if offered, if there was continuing conflict.

<u>*B4:</u> initially requested the system to justify itself. She would never accept a compromise, but would try to justify herself to the system.

* = students who did challenge the system.
° = students who did not actually challenge the system, but would if this were appropriate.

We will return now to the four questions presented at the beginning of this section. Questions 1 and 2 are straightforward to answer: all learners demonstrated an interest in inspecting the contents of the student model, and all either changed or argued with the model, or stated that they would have, had the need arisen. It is of course possible that some students viewed the model out of simple curiosity, though no learner offerred this as a reason in their interview. Nevertheless this possibility needs to be considered. However, even if curiosity is the reason for some inspections of, and attempts to change the student model, such activities may still result in subsequent learner reflection - the main aim of the negotiable model.

After the interaction with the system, learners were asked for their reactions to the approach (questions 3 and 4). In the interview they were asked for their preferences between the following options: did they prefer

3a) no access to the student model;
3b) access, but no power to change the model;
3c) access with the possibility of changing the model;
4a) changing the model with no challenge from the system;
4b) changing the model with system challenges where appropriate.

All nine students stated that they would prefer access and power to change the student model (3c). Seven would prefer the system to challenge their actions if it disagreed (4b), and two would prefer no challenge from the system (4a). The answer to question 3 is clearly straightforward: learners *are* interested in having access to information in their own student model. Most wanted to be able to inform the system of changes in their situation (e.g. if they had forgotten something, or if they suddenly understood something with which they had previously been having difficulty). They wanted to be able to help the system to adapt to their new state. Two learners also thought that they would think more about their learning if they were able to view the student model. One learner felt that she would get a sense of satisfaction in being able to prove the system wrong about her.

Six of the seven learners who wanted the system to challenge them if it disagreed with their attempts to change its confidence in their performance offered

the following reasons, presented here as summarised from the interviews. (One learner was not able to state his reasons.)

A2/A3/A5/B4:	I would learn more by seeing the system justify itself.
A2/B2:	It is important to be able to prove what I think to the system.
B2:	I would be able to prove to myself what I know (e.g. that I got something right for the reasons I think I got it right).
A2:	I would feel more satisfied if I could put forward my point of view.
A3:	Having to justify myself would make me think more about what I know.
A2/B1:	It would make me think more about my learning (in general).

Two learners (A1 and A4) preferred not to be challenged by the system about changes they made to the student model. One stated that she would always want to alter her own confidence measure if it no longer applied, but would prefer not to be 'bothered' with that of the system. Although she liked having the two sets of confidence measures, she would prefer the system to covertly test her knowledge to 'make up its mind'. The other learner who would prefer his changes to remain unchallenged felt that if he were to try to alter something, he would 'want to be sure it got altered!'. He would have more faith in himself than in the system. Nevertheless, he also stated that this was only a preference, and he would not be irritated by the challenge.

Thus the responses for question 4 indicated that most learners wanted the system to challenge them if it disagreed with their attempts to change its confidence in their performance for a particular rule. Learners felt this would make them think more about their learning process. The two learners who would prefer no challenge from the system both actually challenged it in their sessions.

Seven learners liked using the system. Two felt that they would need to use it again before judging (A1 and B4). Eight learners found the system useful. Again, one learner (A1) felt unable to provide an answer without further interaction. Five found the system easy to use, and four found it difficult to find their way around, though three of these said that once they had got used to the system, it became a lot

easier. The main problem appeared to be with the interface, for example 'difficult labelling' on menu items. Use of the system was made more problematic by the fact that, for the purposes of the study, students were not made fully aware of the potential benefits of using the system. They were provided with only a restricted version of the introductory information available to users (which includes the system aims, e.g. the idea of promoting reflection by inspecting and arguing with the student model, though some learners came across this through their browsing in the learning strategies component). This introductory information about the system was withheld to avoid influencing students to think that they *should* be inspecting the student model and reflecting, as this may have biased their approach to the session.

Conclusion

Based on the results of this study it has been demonstrated that not only are students capable of inspecting and understanding their own student model, but they will also argue with it if they disagree with the contents. This has two potential benefits; firstly the student model resulting from such discussion is likely to be more fine-grained and accurate, and secondly this discussion should promote learner reflection. The majority of students in this study did in fact prefer the system to argue back if it disagreed with their attempts at changing the contents of the model, and even those who preferred no such argument still argued!

It was assumed that where subjects disagreed with the contents of the student model, they had understood the model (i.e. the use of two sets of confidence measures). It was also assumed that inspection of the student model or an attempt to alter the contents of the model led to some degree of reflection.

4.6.7 Features of Negotiation

Finally, in this section some of the major features of negotiation, as applicable in the system, are described. Since the method used coincides with 'informal, everyday notions of negotiation', there is no attempt to describe the functioning of negotiation in this system in formal terms. It has been shown that a simple form of (menu-based) negotiation works; formalising this according to some theory or description of negotiation remains an issue for further work. The areas involved in

the targeted negotiation in this system are the representations of beliefs in the student model, and the use of learning strategies[39].

agreement/disagreement

Agreement and disagreement here refer simply to whether the views of the student and system are identical.

Agreement is reached in the student model if the student's own confidence in his use of a particular rule exactly matches the system's confidence in his ability to use that rule. Where there is a large discrepancy in confidence measures the system will initiate discussion aimed at conflict resolution. If the student notices a discrepancy (in what he now believes and his own, or the system's confidence measure), he may or may not initiate discussion. The aim is to reach agreement, but this may be left unanswered.

In contrast, agreement about which learning strategies to pursue is always achieved. The system is not able to prevent the student from using a particular learning strategy (indeed there would usually be little reason to wish to do so - most strategies can be beneficial), and likewise, the system is not able to force the student to use most of the strategies. As strategy use is traced, those strategies which have been used are evident to both sides. It is not an issue that the system believes the student to have grouped information, for example. As long as this occurs within the computer learning environment, the system knows that the student has been grouping his notes through his use of separate note-taking windows. Negotiation here focuses on which strategies would be beneficial for that student.

collaboration

Collaboration implies two agents working together on the same tasks towards a common goal.

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39 For comparison with another system which proposes using the targeted negotiation approach to a different purpose, see Smith's MELODY-ED (Bull & Smith, 1995).

The student and system collaboratively maintain the representations in the student model of the student's beliefs. Either agent has the potential to influence the other towards their own point of view through joint discussion focussed on a single aspect of the common goal of creating accurate representations for the student model.

Future learning strategy use is also collaboratively negotiated: there is a shared goal of deciding on strategies, and having the system support appropriate learning strategies for a particular student.

compromise

Compromise implies the adoption of a view which represents neither agent's position exactly, but is somewhere between what each agent believes, and the compromise position is acceptable to both agents.

In a situation where there is disagreement between a certain belief held by the system about the student, and the equivalent belief of the student, and if the distance between these two belief measures is not too great, a compromise (mid-point) can be agreed on if both parties are in favour.

With learning strategies there is no possibility for compromise, either a student will use a particular strategy, or will not. He may try a new strategy after discussion with the system, but this will either be on his own initiative, or after justified suggestion from the system as part of negotiation, rather than compromise.

judgement

Judgement here refers to whether there is room or reason for one agent to judge the views of the other. (This use of the term judgement does not include any of the moral issues, such as whether a system should be allowed to judge a student.)

Because the negotiation is here about the student's beliefs, the student will have his own ideas about what the correct representation in the student model should be. The system has evidence of student performance gathered during the interaction. From this evidence it is able to conclude its beliefs about the student. Each agent

therefore has clear ideas about the correct representation to be used, and in any situation where one agent disagrees with the other, this agent will necessarily be judging the other's beliefs.

However for discussion of learning strategies the situation for judgement is weaker. Although each agent will have their own view, each is also aware that the other agent has additional knowledge; i.e. the system's *expert knowledge* of learning strategies, and the student's *feelings* about what works for him. Because these are different types of knowledge, it is harder for either agent to judge the other's viewpoint.

justification

Justification refers to the extent to which participants are required to defend and argue for their own views during negotiation.

Both student and system may be required to justify their beliefs to the other in cases of disagreement. In student-initiated negotiation (i.e. the student has disagreed with a representation in the system's student model), the student may demand that the system defend its view before he reconsiders his own position. Alternatively he may decide to justify himself to the system, in order to encourage it to reconsider its representation. The system is also able to request the student to defend himself, and may offer its own justification where it disagrees with a representation in the student's student model. It is through these justifications that each agent tries to influence the other. (It is interesting to recall here that students may in general prefer to view the system justification before offering their own justification. Although there is equal weight accorded to the presentation of each justification, the student is able to choose the sequence in which these are presented.)

The system can justify itself by referring to previous input of the student, or the student's previous statements about the model, or by running its student model to try to prove that the representations contained within can produce evidence supporting its view (e.g. that its assessment of the student is correct - if the student's input matches the output of the system's student model).
The student can justify himself by providing information which is not available to the system, e.g. that he has simply forgotten something; that he had just been

guessing before; that he had previously believed he understood something, but now has evidence to make him unsure.

Justification applies in a weaker form in the case of learning strategies, e.g. the system may state:

> "The combination of your use of the strategies of *note-taking* and *summarization* show that you are very keen on noting down new or relevant information. It would be useful also to consider the *grouping* of information; i.e. organising new or important information in some manner which is meaningful to yourself"

in its attempt to justify its suggestions to the student, but the system is not able to prove that this would be a useful strategy for that student (in the way it could prove that the student had used a grammar rule correctly by producing evidence from the interaction).

resolution

Resolution has to do with eliminating conflict. However, it is clear that there may sometimes be no such resolution. Therefore resolution is also concerned with which agent has the power to make the final decision.

The process of negotiation is aimed at resolving conflict in the student model. Where an agreed resolution is not possible, the final decision is made by that agent who owns the view which is being challenged, i.e. the system has ultimate control over the representations in the system's student model, and the student has final say over the student's student model.

symmetry

The definition of interaction symmetry used is, as previously stated, based on Baker's (1990) notion that each agent should be provided with the same set of dialogue moves.

Maintenance of the student model will not necessarily be symmetrical in practice, but can (and is intended to) be. The same possibilities are provided to each side.

Either agent may initiate negotiation of the model about the learner's beliefs or learning strategies, in the form of a challenge or enquiry. The system may challenge the student about the student's student model, and the student may challenge the system about the system's student model. The student may also change his own student model. Both participants may also provide justifications for their beliefs, and request information from the other. There is also symmetry of power of resolution (see resolution above). Nevertheless, although symmetry of interaction is desired, and indeed, is possible, the student is not forced to take part in negotiation to a great extent.

4.7 What Mr. Collins Does

In this section a brief summary of 'what Mr. Collins does' is given, in order to provide a convenient overview.

4.7.1 The Issues

Exercises

There are two kinds of task in the current implementation - both concerned with pronoun placement. In the first type the student is presented with a sentence with the pronoun missing. The pronoun is given separately, and it must be placed correctly into the sentence. This has been implemented for 2 of the rules. The other kind of exercise has been implemented for all 12 rules: students are provided with an English sentence, and must translate this into Portuguese. All vocabulary is provided. Both exercise types are here used purely as a vehicle to demonstrate collaborative student modelling - no claims are made as to the validity of these tasks for language learning in a computational context.

Performance

In addition to recognising correct input, the system handles errors of pronoun placement, problems with phonetic contractions and misuse (or non-use) of hyphens. 'Incompatible' errors are also catered for.

Mal-rules are ordered in the system's knowledge base in order of frequency to ensure that, if there is no information in the student model to guide the system's identification of an error, it follows the most likely search route. Misconceptions are related to mal-rules, and represented in the student model in conjunction with the rule to which they apply.

Language transfer

In cases where there are misconceptions which are not Portuguese-based, or which *may* not be based on overgeneralisation from Portuguese, Mr. Collins searches its knowledge of the rules of other languages to see if any of these might be the source of the difficulty. Mr. Collins considers transfer from both native and non-native background languages, and calculates which of these languages is the most likely source of transfer for a particular student, based on their proficiency in each of the languages known (see Ringbom, 1983), and how similar they perceive Portuguese to be to each of their other languages (see Kellerman, 1977).

Because of the system's representations of other languages apart from Portuguese, the learner may obtain explicit comparisons of the rules of Portuguese to those of other languages.

Acquisition sequence

Mr. Collins uses the typical sequence of acquisition of the target rules to support diagnosis - i.e. the system has a knowledge of which rules tend to be acquired early, and which, late, etc.

Learning strategies

The learning strategy component has been based around O'Malley and Chamot's (1990) classification of metacognitive, cognitive and social strategies. Information is available to the student about learning strategies, and also about how these may be used in this implementation. An additional five categories have been built on top of O'Malley and Chamot's

classification, based on the principle of 'ease of introduction and comprehension'.

All strategy use by students is traced by the system; thus the system *knows* what the student has done, and can therefore discuss with the student his use of learning strategies from a knowledgeable standpoint.

The system can also suggest potentially useful strategies based on information volunteered by the learner regarding his preferences about different methodologies previously experienced.

Language awareness

Language awareness is not explicitly represented in Mr. Collins, but the system has been designed to promote language awareness by allowing the student access to most of the information available to the system, including (and in particular), the student model. Awareness is enhanced further by encouraging the student to negotiate the contents of the student model (see below).

Collaborative student modelling

Collaborative student modelling is a novel approach to student modelling in which the student and system negotiate the contents of the model in cases where they disagree.

No specific student modelling approach is implied; the important factor is that the technique used is effective in its own context, and there is a facility to include student/system negotiation into the framework. This implementation uses:

- DCG rules (of the target and other languages) and mal-rules (of target rules), combined with student and system confidence levels in the student's use of these rules;
- a continuum on which these rules are located, to represent development over time;

- declarative statements about learning strategies used.

4.7.2 Building Mr. Collins

Learner profile

- The system requests information from the student to initialise the student model.
- This information is quite limited for two reasons:
  1. To limit the amount of questions asked of the student at this stage, in order not to 'annoy him'.
  2. The information provided may not be reliable, and is intended only as a starting point.

Current model

- The current model is built during the interaction through conventional inferencing techniques based on student input.
- Information may also be offered by the student.
- The system may question the student directly if it requires a specific piece of information.
- There is collaborative maintenance of the current model in the form of (menu-based) student/system discussion.

Previous models

- The previous models are obtained by copying the contents of the present current model, each previous model thereby moving back one position.

Intermediate models

- The intermediate models are predicted according to the learner's current position on the developmental sequence (student model continuum), and matched to the appropriate predefined (DCG) grammar rules.

Expert model

- The expert model is composed of the target (DCG) grammar rules.

It can be seen from the above that different methods apply to the construction of the different parts of the student model continuum. The learner has most influence over the current model, as it is this component that he may negotiate, but the contents of the current model necessarily indirectly influence the content of the previous and intermediate models.

Chapter 5 presents a student's interaction with the system, illustrating some of the issues discussed in chapter 4.

Chapter 5

What Happens During an Interaction with Mr. Collins

This chapter describes a learner's interaction with the system (learner B2 from study 9). Learner B2 volunteered to do another session with the system because she had (unexpectedly!) enjoyed her previous interaction, and was interested to learn some more. Although she was not requested to give a think-aloud protocol, she nevertheless frequently described what she was thinking. Some of the description in the following extract therefore draws on the student's own comments, which were noted by the experimenter. (This was not performed in any systematic way, since the verbal report had not been anticipated.) B2 was not directed in any way as to how she should interact with the system, or how long she should spend using it. The following is therefore one example of how an interaction may develop.

1. *Student B2 was aware that the formation of phonetic contractions was not straightforward, and was very conscious of this as a potential difficulty. This led to consideration of contractions when these were inappropriate. Indeed, her first action was to request a description of the rules for phonetic contractions.*

The learner selected the option 'question grammar' from the menu.
A dialog box appeared in which the following options were offered:

- **Portuguese Rules;**
- **Examples;**
- **Aspects of Transfer.**

The learner clicked on the button for 'Portuguese rules'.
A further dialogue box appeared asking whether she wished to view the rules for:

- **pronoun placement;**
- **phonetic contractions.**

The learner clicked on the button for 'phonetic contractions'.

Stored text explaining the rules for phonetic contractions was loaded into a new window for the learner to read:

PHONETIC CONTRACTIONS
These occur with some post-verbal pronouns

1. **If the verb form ends in: r, s, z**
   and the pronoun is: o, a, os, as

   r, s, z is omitted
   l is attached to the front of the pronoun
   (lo, la, los, las)

   and if the final syllable of the verb is stressed, a written accent is usually required
   (a -> á, e -> ê, i -> í)

2. **If the verb form ends in: a nasal sound**

   n is attached to the front of the pronoun
   (no, na, nos, nas)
   (The final nasal sound is NOT omitted)

3. **Before: reflexive nos**

   final s is omitted

4. **Tens + o ALWAYS becomes:**

   tem-lo

2. *B2 then attempted a negative translation question, however her first attempt was incorrect (* Não levaríamos la), and was identified as a pronoun placement error . (Although there are multiple difficulties with this sentence, this is the most crucial at this stage since different non-placement errors may occur when the pronoun is in a different position. Therefore placement errors are dealt with first, to avoid confusing learners with interactions about problems which may well not occur when they learn to place the pronoun correctly.) B2 then remembered the hyphen and added this. At this stage her confidence in her answer increased from C to A.*

The learner selected the option 'translation sentences' from the menu.
A further (scrolling) menu appeared, offering a list of rules for the learner to select the type of sentence to try. She chose 'negative clauses'.
A dialog box appeared with the English sentence:

We would not take it,

and the Portuguese vocabulary with the words listed in alphabetical order:

a, levaríamos, não.

An edit field was provided for the learner to type her response. The learner wrote her translation of the sentence, and offered it to the system:

Não levaríamos la

A dialog box appeared asking her to state her degree of confidence.
The learner clicked on 'unsure' to indicate a confidence level of C.
The sentence was then parsed.
The correct sentence should have been: não a levaríamos, which could have been parsed by the rule s --> negative, pronoun, verb, from the expert model. After checking the expert model and failing to find a match, the system consulted the list of mal-rules describing common errors. First the current model was consulted, to see whether any common misconceptions were contained from which a mal-rule could be generated to match the mal-rules held in the system:

e.g. Student(negatives,a,3,[PreVHyph=1,NonV=0,WrongPro=3,.....])

could be used to generate the mal-rules:

xS --> negative, pronoun, hyphen, verb;

xS --> negative, other_pronoun, verb.

However, since this was the start of the first interaction[1] there was no stored information in the current model. Thus the usual progression through the student model continuum was not productive. The first match was found for one of the general mal-rules for a placement error:

xS --> negative, verb, pronoun.

The fact that the pronoun itself was incorrect was ignored while placement difficulties were being sought.

A second attempt was made:

Não levaríamos-la

The learner clicked on 'very sure' in the dialog box to indicate a confidence level of A.

Again the sentence was parsed, but it failed to match the correct rule (s --> negative, pronoun, verb), but matched the same mal-rule as in the previous attempt (xS --> negative, verb, pronoun), indicating a continuing placement error.

(In a full system a more exact treatment of errors would have been followed. The mal-rule found here is not intended as the final information on which to base feedback to the student, but simply as initial information for the student model, which should be built upon.)

3. *On discovering there still to be an error in her sentence, B2 again checked the rules for the use of phonetic contractions, and also checked the placement rules.*

See 1 for method, and for rules presented for phonetic contractions.

The rules for pronoun placement were presented as follows:

---

1 Since this second interaction had not been planned, the original student model for B2 had not been kept.

The pronoun is PREVERBAL in:	The pronoun is POSTVERBAL in:
negative clauses	affirmative main clauses
open questions	positive imperatives
certain adverbial phrases	infinitives
relative clauses	yes/no questions
subordinate clauses	

The pronoun is an INFIX in:	The pronoun is BETWEEN:
future tense	aux & past participle (in affirmative main clauses)
conditional tense	

4. *The student then realised that she had an error of pronoun placement*[2], *and in the next attempt placed the pronoun into the correct position, but with a slightly lower level of confidence than previously. However, the learner was still trying to use contractions where these are not required, and assumed her problem to be one of incorrect contraction formation.*

The English translation and Portuguese vocabulary were given as in 2.
The student entered:

Não la-levaríamos

She selected 'almost sure', for confidence measure B.

---

2 This continuing placement error would be less likely in a full system, since the tutoring or coaching approach used would presumably provide more helpful feedback. This is not an issue for the construction of Mr. Collins: all that is required here is to know that some intervention is needed at this point, and to ensure that insertion of this intervention is possible within the functioning of the system. I.e. where currently in the interaction a particular error type is reported, this space would be further used for some kind of 'treatment' of the problem.

The system could not recognise this type of error; there is not only a wrongly used hyphen, but also a confusion over phonetic contractions in a *pre-verbal* context.
The usual parsing sequence through the student model continuum was followed, but no matches for either the correct rule, or for mal-rules, were found. The mal-rules:

xS --> negative, pronoun, hyphen, verb
xS --> negative, other_pronoun, verb

were both tested, but as there is no rule for this particular combined error, the system here simply recorded the fact that there was an (unidentified) error[3].

5. *B2 again consulted the rules for phonetic contractions. At this point she realised that contractions are only required in some cases where the pronoun <u>follows</u> the verb, and were therefore not necessary in the current context.*
She stated:

"Ah, the pronoun doesn't follow!"

See 1.

6. *B2's next three attempts were correct. She initially had a confidence measure of B. With the next (new) sentence this decreased to C, but subsequently returned to B.*

The question was given as in 2.
The learner entered:

Não a levaríamos

Confidence level B was given.
The sentence was parsed, and the expert model checked. As a match was found here, there were no further system actions.
The same procedure followed for the next two sentences:

Não os tenho comigo (confidence = C);
Não o comerei amanhã (confidence = B).

---

3 Since this interaction the system has been improved, and could now deal with this error.

7. *At this point the learner made some notes about the positioning of pronouns in negative clauses.*

The learner selected the option 'notes' from the menu.
A dialog box appeared, with three buttons from which to choose the notes window required.
The learner clicked on her choice, and this window became visible. There were no notes to display. The learner added her notes as below; then closed the window.

The pronoun (it, them) goes before the verb - negatives

8. *The student then decided to review the grammar information for pronoun placement, before attempting positive main clauses. Because she found the pronoun to be post-verbal in this context (and it may therefore involve phonetic contractions), she also reviewed the contraction rules.*

See 1 & 3.

9. *B2 then selected to do some non-translation exercises[4] for pronoun placement in affirmative main clauses. Her inspection of the grammar rules had reminded her that the pronoun should be post-verbal. She requested translations to be available on screen.*

The learner selected the option 'translation' from the menu.
This ensured that a translation of the current sentence appeared in a window at the bottom of the screen, by setting 'show_translation' to true.

10. *B2 then completed three sentences correctly - the first with a confidence measure of B, and the others with A.*

The learner selected the option 'placement exercises' from the menu.

---

4 i.e. of the type:
Please place the pronoun 'o' in the correct position in the sentence: *O homem comeu rapidamente.*

A further (scrolling) menu appeared, offering a list of rules for the learner to select the type of sentence to try. She chose 'positive main clauses'.
A dialog box appeared with the instruction

Please place the pronoun 'os' in the correct position in:

Ele limpa usando muito sabão.

An edit field was provided where the learner could click and type the pronoun into the appropriate position in the given sentence (also making any other changes which were necessary). The learner added the pronoun to the sentence, giving:

Ele limpa-os usando muito sabão

and offered it to the system.
A dialog box appeared asking her to state her degree of confidence. The learner clicked on 'almost sure' to indicate a confidence level of B.
The sentence was then parsed, and identified as correct during the first parse by the expert model, when it matched the rule:

s --> subject_pronoun, verb, hyphen, pronoun, endchunk[5].

As a match was found there were no further system actions.
Two further sentences were offered:

Compra-a aqui;
Tenho-as às quintas,

each with confidence measure A.

11. *B2 subsequently noted down some information about pronoun usage in positive main clauses.*

The learner selected the option 'notes' from the menu.
A dialog box appeared, with three buttons from which to choose the notes window required.
The learner clicked on her choice, and this window became visible. Her previous notes appeared. The learner added her new notes below these, and closed the window:

---

5 For reasons of efficiency the rules for some parts of a sentence may also be stored as 'startchunk' or 'endchunk'. These will be checked first, before individual words are sought separately.

The pronoun (it, them) goes before the verb - negatives

the pronoun (it, them) goes after the verb eg: -os
if verb ends with r, s or z drop r, s or z and place a l in frount of the pronoun - main clause
— because it is postverble

12. *The learner then decided that she would like to tell the system about her earlier negative experiences of language learning. (B2 had been taught by the communicative method, and English was rarely used. She simply had not understood anything). She commented:*

"I didn't understand what was going on!"

When finding out that B2 did not like the communicative approach, the system suggested that she use grammar rules, as she had been doing throughout the interaction.

The learner selected the option 'offer information' from the menu.

A dialog box appeared, with the options:

- **past learning experiences;**
- **my difficulties.**

The learner clicked on 'past learning experiences', and was offered the following options in a dialog box, from which to select the most appropriate:

- **I disliked grammar;**
- **I liked grammar;**
- **I disliked the communicative approach;**
- **I disliked teacher dominance;**
- **I liked having an expert teacher.**

The learner clicked on the button 'I disliked the communicative approach'.

The system searched its knowledge base, finding the rule which states that a learner who does not like the communicative method may find explicit rules useful:

```
xCommunicative(Student):-
        dislikes(Student,communicative),
        system_suggest(Student,grammar).
```

The system presented this information (stored as canned text) to the learner:

> **Because you did not find the communicative approach very helpful in the past, you may find it easier to look at explicit grammar rules.**

This reassured the learner that her current method of consulting rules was an effective way for her to work.

13. *The student then viewed the placement rules once more, and requested examples.*

See 3 for placement rules.
The method of viewing examples occurs in an identical manner. The examples were presented as follows:

The pronoun is PREVERBAL in:	**The pronoun is POSTVERBAL in:**
Não os compra	Compra-os
Quem os compra?	Compra-os!
Também os compra	Quer comprá-los
Vejo o homem que os compra	Compra-os?
Sei porque os compra	

The pronoun is an INFIX in:	**The pronoun is BETWEEN:**
Comprá-los-á	Tem-nos comprado
Comprá-los-ia	

14. *B2 subsequently attempted a translation sentence involving infinitives (confidence = B). She realised that a phonetic contraction will be required as the final letter of the verb form was r. She removed the r and added the l to the pronoun, but did not remember to add the accent. The system identified this as a contraction error.*

The learner selected the option 'translation sentences' as in 2, but this time chose the option 'clauses with infinitives'.
She entered the sentence:

Quer estaciona-lo aqui.

The correct sentence should have been: *Quer estacioná-lo aqui*, which would have been parsed by (this simplified version of) the rule:

s --> verb1, modified_infinitive, hyphen, lpronoun, endchunk.

The system identified the error as a contraction error from (this simplified version of) the rule:

xS --> verb1, any_infinitive_form, hyphen, any_pronoun,
endchunk.

15. *B2 therefore again viewed the rules for phonetic contractions.*

See 1.

16. *She realised her mistake and correctly produced the sentence (though her confidence remained at B).*

The question was given as in 14.
B2 entered:

Quer estacioná-lo aqui. (confidence = B)

The sentence was parsed, and the expert model checked. A match was found with (this simplified version of) the rule:

s --> verb1, modified_infinitive, hyphen, lpronoun, endchunk.

There were therefore no further system actions.

17. *At this stage the learner felt that she had 'an idea' of what was involved in pronoun placement in these three types of sentence, and decided to view the*

student model. She looked at the information on main clauses and saw that her own confidence level was recorded as A, and that of the system as. 1. She felt that this was too high, and chose to change her own confidence measure to B.

The learner selected the option 'question model' from the menu.
A dialog box appeared, with the options:

- **transfer;**
- **learning strategies;**
- **proficiency.**

The learner clicked on 'proficiency', and was offered another menu listing the sentence types. She then selected 'positive main clauses'.
A dialog box was displayed with the following buttons:

- **learner profile;**
- **previous model;**
- **current model;**
- **next model;**
- **expert model;**
- **make notes;**
- **change CURRENT model.**

The learner selected 'current model'.
The system displayed its own and the learner's confidence measures in this type of sentence in table format; the values were retrieved from the student model and presented via a template.

	YOUR CONFIDENCE (a - d)	SYSTEM CONFIDENCE (1 - 4)
positive main clauses:	•very sure (a)	•very sure (1)
e.g. Compra-os		

The previous dialog box remained visible, and the learner selected 'change CURRENT model'.
A dialog box appeared, with the following options:

- **change languages;**
- **change strategies;**
- **change proficiency.**

The student selected 'change proficiency'.

A further dialog box appeared, which stated the learner's current confidence (A) and its own confidence (1), with buttons to:

- **change OWN confidence measure;**
- **challenge SYSTEM'S confidence measure.**

The learner clicked on 'change OWN confidence measure'.

Another dialog box was presented, with buttons for the learner to choose the level she wished to change her confidence to. She selected B.

18. *The system responded that it had greater confidence in the student than she had herself, though the difference was not so great that the two beliefs were incompatible.*

The system compared the two confidence measures to ascertain whether they were compatible. It checked first for the following condition:

```
compatible(NewStuBelief,SysBelief):-
        NewStuBelief is SysBelief[6].
```

Then for acceptabiliy:

```
acceptable(NewStuBelief,SysBelief):-
        NewStuBelief is SysBelief - 1.
acceptable(NewStuBelief,SysBelief):-
        NewStuBelief is SysBelief + 1.
```

NewStuBelief here is equal to B, and SysBelief is 1. Thus the student's choice matches 'acceptable'.

The system responded, stating that it disagreed with the student's action, but nevertheless allowed the change to go ahead without further discussion. This message was drawn from stored text, selected by comparing the student's chosen (asserted) belief measure to that of the system (as above). The confidence levels were inserted into gaps in this textual template:

---

6 Student belief measures are first translated to numerical form before comparison.

MAIN CLAUSES: You have changed your confidence measure from a to b. This new confidence value is slightly lower than that of the system, though not different enough to be incompatible. You are very proficient in the use of this rule, and the system has greater confidence in your ability than you appear to have yourself. Your last attempts at this rule have all been perfect.

The student commented:

"I don't think I'm that good."

19. *The next learner action was a challenge to the system's confidence. B2 attempted to change the system's belief measure from 1 to 2, in order that it become identical to her own.*

The main dialog box (of 17) was still visible. The learner again chose the option 'change CURRENT model', and again chose 'change proficiency'.

The system displayed its own and the learner's new confidence measures:

	YOUR CONFIDENCE (a - d)	SYSTEM CONFIDENCE (1 - 4)
positive main clauses:	•almost sure (b)	•very sure (1)
e.g. Compra-os		

The learner then clicked on 'challenge SYSTEM'S confidence measure'.

A dialog box was presented, with buttons for selecting the level she wished to alter the system's confidence to. She selected 'almost sure - 2'.

The system checked for compatibility of the two belief measures by comparing the two versions: its own original belief, and that to which the student wished to change it. It checked first for the following condition:

compatible(NewSysBelief,SysBelief):- NewSysBelief is SysBelief.

NewSysBelief here is equal to 2, and SysBelief is 1. Thus the above rule was not applicable.

20. *However, because the system disagreed, it demanded to know why the student believed it should change its confidence measure. The learner selected to justify her reasons, and explained that she was now less sure. She felt that she was too hesitant in the application of the rule, and commented:*

"I can't do them quickly enough."

The system displayed a further dialog box with a message stating that it disagreed. The following options were provided:

- **justify your reasons;**
- **view student model;**
- **test system's assessment.**

The learner selected 'justify your reasons'.

A further dialog box was displayed, with the following choices:

- **FORGOTTEN what I knew;**
- **NOW LESS SURE than before;**
- **was GUESSING.**

The learner clicked on 'NOW LESS SURE than before'.

21. *In order to convince the system she requested a test sentence, which she answered correctly.*

Another dialog box was displayed, with the options:

- **try another sentence;**
- **view grammar rules;**
- **view examples.**

The learner selected 'try another sentence'.

A test sentence ([compra, `-`, a, aqui]) was retrieved from the database, checked against those already attempted to ensure that it had not already been encountered, and offered as in 10.
The learner placed the pronoun correctly:

Compra-a aqui.

This matched the rule:

s --> verb, hyphen, pronoun, endchunk

in the expert model.

22. *Because of this correct response the system was not persuaded to decrease its confidence level. The learner decided to accept the system's decision even though she disagreed, since the difference between the two was not great.*

The system presented a message to the learner stating that her correct performance had not convinced it to decrease its confidence in her ability. This information was retrieved according to the state (from the system's point of view) of:

student = correct &
student = decrease system &
system = disagree.

The message was formed by filling a template.

> MAIN CLAUSES: You have not produced enough evidence to change the system's confidence to 2. The current system confidence is: 1

23. *Learner B2 then decided to check that she still remembered how to complete negative clauses. She first checked the placement rules.*

See 3

24. *She then attempted a translation sentence. Her attempt was correct, though her confidence remained at level B.*

As 6, but with the input sentence:

Não se incomode.

25. *B2 suddenly realised that she had not noted the use of pronouns with infinitives, and did this (comparing to positive main clauses).*

The learner selected to make notes as in 11. She added her notes as below:

> The pronoun (it, them) goes before the verb - negatives
>
> the pronoun (it, them) goes after the verb eg: -os
> if verb ends with r, s or z drop r, s or z and place a l in frount of the pronoun - main clause
> — because it is postverble
>
> the pronoun (it, them) goes after the verb as above - infinitive

26. *At this point the learner decided to investigate learning strategies - something she had wanted to do sooner, but had not got around to. She asked for a description of the strategy of questioning.*

The learner selected the option 'learning strategies' from the menu. A dialog box appeared, with the options:

- **my use of strategies;**
- **strategy help;**
- **general strategy information;**
- **(other strategies).**

The learner clicked on 'general strategy information', and another dialog box appeared, offering the options:

- **metacognitive strategies;**
- **cognitive strategies;**
- **social strategies.**

The learner selected 'social strategies'. A dialog box was displayed with the buttons for each of the social strategies.

The learner selected 'questioning'.

Canned text explaining questioning was loaded into a new window:

> **Questioning involves asking for explanations, verifications or examples.**
> **In this system you may use questioning:**
> **- with reference to the target grammar, relationships between the target and other languages (by selecting "question grammar" from the STUDENT MENU), or**
> **- with reference to learning strategies (by selecting "learning strategies" from the STUDENT MENU), or**
> **- you may question the contents of the system's representation of your own knowledge and beliefs (by selecting "question model" from the STUDENT MENU).**

27. *B2 then decided to investigate her own use of strategies.*

She selected the option 'learning strategies' from the menu, as in 26.

She selected 'my use of strategies' by clicking on the appropriate button in the dialog box.

28. *The frequency of use of those strategies she had demonstrated, was summarised.*

The system presented a list of strategies which had been used by the student, together with the frequency of use of each strategy. The figures and strategies were obtained by checking the database of asserted facts about which strategies had been evidenced, e.g.:

```
student_model_evidence(resourcing);
student_model_evidence(working_it_out),
```

and then consulting the frequency value stored (incremented each time a strategy is used):

```
frequency(resourcing,14);
frequency(questioning,12);
frequency(cooperation,3).
```

This information was fitted into templates and posted in a new window:

METACOGNITIVE STRATEGIES	
Strategy Planning:	**1**
student initiated:	**(1)**
system initiated:	**(0)**
Self-evaluation:	**13**
COGNITIVE STRATEGIES	
Resourcing:	**14**
domain inspections:	**(10)**
student model inspections:	**(1)**
dictionary inspections:	**(0)**
interaction inspections:	**(0)**
notes:	**(3)**
Deduction:	**9**
Inferencing:	**1**
Noting:	**3**
Translation:	**3**
SOCIAL STRATEGIES	
Questioning	**12**
Cooperation	**3**

29. *B2 then decided to ask for suggestions about other approaches to consider.*

She selected the option 'learning strategies' from the menu, as in 26. She selected 'strategy help' by clicking on the appropriate button in the dialog box.

30. *The system suggested self-monitoring, because B2 had evidenced use of the information seeking strategies, and also noting and self-evaluation (see figure 4.17). B2 then requested a description of self-monitoring, in order to consider whether this might be appropriate for her.*

The system checked the student model for evidence of strategy use as in 28, then searched the strategy domain knowledge for a suggestion of a suitable strategy to be considered, according to the combination of strategies already used by the student. In this case there was student model evidence for:

strategy planning, self evaluation, resourcing, deduction,
inferencing, noting, translation, questioning, cooperation.

The system's suggestion was found by searching:

ACTIVELY SEEKING INFORMATION --> NOTING SELF ASSESSMENT
NOTING --> note taking summarization
self evaluation --> self monitoring strategy planning

The explanation of the system's choice was fitted into templates and posted in a new window:

Because you already use the information seeking strategies of resourcing, deduction, inferencing, questioning and cooperation you know how to access the information you require. You also use self-evaluation to evaluate your performance once you have completed the task. You could also try self-monitoring. This strategy is similar, but it is used while you are still carrying out the task.

The learner then selected to view information about the strategy of self monitoring, and the information was presented (as in 26).

Self-monitoring involves checking, verifying or correcting your own performance DURING the task.
The issues relevant in this system are checking production, which may be in the form of visual monitoring (i.e. whether a sentence looks right), strategy checking (i.e. assessing how well a particular strategy works), and double checking, which includes consideration of alternatives.
You may alter (i.e. double check) your sentence before it is assessed by the system, by retrieving it from the dialog box which appears after you have entered your sentence.
It is helpful if you tell the system which type(s) of self-monitoring you use (or indicate the use of none). You may inform the system about your use (or lack of use) of this strategy by selecting "learning strategies" from the STUDENT MENU, and then choosing "Your Use of Strategies".

The following is the trace of the interaction described above, as it appears for students to consult[7] (at the time of interaction or later). In most cases in the system, writing to this 'interaction window' occurs after the event concerned, is resolved.

---

7 Numbers have been added for ease of cross-reference between the interaction trace and the preceding discussion. The positioning of these numbers through the trace is arbitrary.

20 . 8 . 1996
7.35pm

1) QUESTION GRAMMAR: phonetic contractions

2) translation: Não levaríamos la (c)
*placement error

translation: Não levaríamos-la (a)
*placement error

3) QUESTION GRAMMAR: phonetic contractions
QUESTION GRAMMAR: placement rules

4) translation: Não la-levaríamos (b)
*error

5) QUESTION GRAMMAR: phonetic contractions

6) translation: Não a levaríamos (b)
translation: Não os tenho comigo (c)
translation: Não o comerei amanhã (b)

7) NOTES

8) QUESTION GRAMMAR: placement rules
QUESTION GRAMMAR: phonetic contractions

9) TRANSLATIONS REQUESTED
10) Ele limpa-os usando muito sabão (b)
Compra-a aqui (a)
Tenho-as às quintas (a)

11) NOTES

12) VOLUNTEERED INFORMATION about past learning:
"I disliked the communicative approach"
--> system suggestion: grammar rules

13) QUESTION GRAMMAR: placement rules
QUESTION GRAMMAR: examples

14) translation: Quer estaciona-lo aqui (b)
*contraction error

15) QUESTION GRAMMAR: phonetic contractions

16) translation: Quer estacioná-lo aqui (b)

17) QUESTION MODEL: current model
- proficiency

:::::::: positive main clauses ::::::::
change own confidence measure
a --> b
(system's confidence = 1)

18)
:::::::: positive main clauses ::::::::

19) challenge system's confidence
change system's confidence
1 --> 2
(own confidence = b)

20) justify reasons: now less sure

21) Compra-a aqui (b)

22) • the system is not yet convinced.
current system confidence: 1

23) QUESTION GRAMMAR: placement rules

24) translation: Não se incomode (b)

25) NOTES

26) LEARNING STRATEGIES: social strategies
- questioning

27) LEARNING STRATEGIES: my use of strategies

28)

29) LEARNING STRATEGIES: strategy help

30) —> system suggestion: self-monitoring

LEARNING STRATEGIES: metacognitive strategies
- self-monitoring

The above interaction is kept for the student to consult, either at the time, or later. The learner does not have to perform any actions to preserve this information, but may delete it if desired (for example, once the learner has moved on, and no longer needs the full trace of every session). Any other information provided by the system during the interaction may be written or pasted by the student into their own note windows. Noted information will then also be available for later consultation if required.

The system's preservation of information in the manner illustrated above has a number of benefits for learners; the most important being the fact that it is a record of what the student has actually *done*, and, if consulted, can serve as a source for learner reflection. In addition, during argumentation with the system about belief measures, the student has a record which he may consult if there are any disagreements. Indeed, during the above interaction, at point 17 the learner muttered something akin to "I didn't think I was very sure!", believing that she had not told the system she was sure. However, looking back at point 10 it can be seen that of her three attempts at this type of sentence, in her first she was 'almost sure', but in the second and third she claimed to be 'very sure'. In this case the learner did not review the trace to see this information, but it would have been a possible course of action to follow. Since everything the learner does is recorded in this way, if prefered, the student does not have to rely on the system to highlight areas of

difficulty - he may do this himself by comparing his performance and approaches to the task throughout an earlier interaction.

Despite the advantages of having available a summary of everything the student does, there are also some limitiations. The example above gives all the learner's attempted sentences, together with her confidence measures and the diagnosis of any errors, and also her attempts at changing the student model and searches for information about learning strategies. This provides her with a clear indication of what she has done, but says nothing of what she did *not* do. If a learner relies too heavily on the interaction trace as the basis for reflection, unless this is done very critically there may be little progression in the area of language awareness. For example, when viewing the student model, B2 inspected only the current model. From the dialog box enabling her to select this option it was clear that there were other alternatives, but the question of whether she will remember this at a later time if simply studying her interaction trace, is unanswered. It would, of course, have been possible to list all alternatives offered, in the trace (as was done in the initial explanation of this section), but there would then be the problem of too much information obscuring the important points. It is difficult to know when it is best to stop recording; this could be a matter for empirical investigation. Other functionalities of the system are also not apparent in the above interaction trace; for example, there is no mention of other languages. This may have been because this learner did not find that aspect appropriate, or it may have been because she was not aware of this possibility, or did not feel confident enough to interact about it. It will be the task of the full learning environment to ensure that there is a balance between what the learner can review about the interaction, and awareness of aspects not included in the trace. (For an independent evaluation of the above interaction see appendix G.)

The following is the student model for B2, which resulted from the above interaction:

(simplified) expert model:

```
s --> negative, pronoun, verb.
s --> qword, pronoun, verb, qm.              % qm = question mark
s --> verb, hyphen, pronoun.
s --> verb, hyphen, pronoun, em.             % em = exclamation mark
s --> verb1, modified_infinitive, hyphen, !pronoun.
s --> adverb, pronoun, verb.
s --> main, relword, pronoun, verb.          % main = main clause (all
                                             % main clauses are also
                                             % defined as 'main'
s --> main, subword, pronoun, verb.
s --> aux, hyphen, pp.                       % aux = auxiliary;
                                             % pp = past participle
s --> verb, hyphen, pronoun, qm.
s --> modified_infinitive, hyphen, pronoun, hyphen, futend.
                                             % futend = future tense ending
s --> modified_infinitive, hyphen, pronoun, hyphen, condend.
                                             % condend = conditional tense
                                             % ending

suggested_strategy( Used_strategy, New_strategy ).
```

(simplified) intermediate model at 'expert - 1':

```
s --> negative, pronoun, verb.
s --> qword, pronoun, verb, qm.
s --> verb, hyphen, pronoun.
s --> verb, hyphen, pronoun, em.
s --> verb1, modified_infinitive, hyphen, !pronoun.
s --> adverb, pronoun, verb.
s --> main, relword, pronoun, verb.
s --> main, subword, pronoun, verb.
s --> aux, hyphen, pp.
s --> verb, hyphen, pronoun, qm.
```

(simplified) intermediate model at 'expert - 2':

s --> negative, pronoun, verb.
s --> qword, pronoun, verb, qm.
s --> verb, hyphen, pronoun.
s --> verb, hyphen, pronoun, em.
s --> verb1, modified_infinitive, hyphen, lpronoun.
s --> adverb, pronoun, verb.
s --> main, relword, pronoun, verb.
s --> main, subword, pronoun, verb.
s --> aux, hyphen, pp.

(simplified) intermediate model at 'expert - 3':

s --> negative, pronoun, verb.
s --> qword, pronoun, verb, qm.
s --> verb, hyphen, pronoun.
s --> verb, hyphen, pronoun, em.
s --> verb1, modified_infinitive, hyphen, lpronoun.
s --> adverb, pronoun, verb.
s --> main, relword, pronoun, verb.

(simplified) next intermediate model for B2 ('expert - 4'):

s --> negative, pronoun, verb.
s --> qword, pronoun, verb, qm.
s --> verb, hyphen, pronoun.
s --> verb, hyphen, pronoun, em.

current model for B2:

negative(7,[b,2],[Err=1]).
affmain(4,[b,1],[]).
infinitive(2,[],[Contrac=1]).

strategy_frequency(strategy_planning, 4, [1,0]).
strategy_frequency(self_evaluation, 13, _).
strategy_frequency(resourcing, 14, [10,1,0,0,3]).
strategy_frequency(deduction, 9, _).
strategy_frequency(inferencing , 1, _).
strategy_frequency(noting, 3, _).
strategy_frequency(translation, 3, _).
strategy_frequency(questioning, 15, _).
strategy_frequency(cooperation, 3, _).

previous model for B2:

negative(6,[b,2],[PostV=1,Err=1]).
affmain(3,[a,1],[]).
infinitive(2,[],[Contrac=1]).

strategy_frequency(self_evaluation, 13, _).
strategy_frequency(resourcing, 10, 8,0,0,0,2]).
strategy_frequency(deduction, 7, _).
strategy_frequency(inferencing, 1, _).
strategy_frequency(noting, 2, _).
strategy_frequency(translation, 3, _).
strategy_frequency(questioning, 8, _).
strategy_frequency(cooperation, 3, _).

learner profile for B2:

not available.

The *expert model* as illustrated above contains (a simplified version of) the rules of the domain. It contains no information as to which learning strategies should be used, as this depends very much on the individual. However, it does contain a rule to enable it to calculate appropriate strategies to suggest, given a particular student's current strategy use. (See figure 4.4.3).

The *intermediate model* 'expert - 1' gives the same rules, but without those for the future and conditional tenses, as these are the last to be acquired. 'Expert - 2' has the rules of 'expert - 1', with the exception of the rule for yes/no questions. 'Expert - 3' is as 'expert - 2' minus the rules for subordinate clauses and auxiliary with past participle, giving therefore all the rules in the first three stages on the acquisition sequence. (See section 4.3.1). 'Expert - 4' is the next intermediate model, and contains the rules for the first two stages. The intermediate models do not contain learning strategy information.

The *current model* holds declarative information for the rules so far attempted: negative clauses, affirmative main clauses and infinitives. Seven attempts have been made at negative sentences. Based on the last five of these tries (as only the last five attempts at each sentnence type are used for model calculations), both student and system are 'almost sure' that the student can perform correctly. For affirmative main clauses the student is 'almost sure', and the system 'very sure' of her correct performance. In the case of infinitives there are only two attempts: this is an insufficient number for belief measures to be recorded in the student model - another try is needed before confidence levels are included[8]. These declarative statements are used in conjunction with the expert rules, mal-rules and rules of other languages.

Frequency of use of each strategy is represented, in order that the 'suggested_strategy' rule of the expert model may use these statements in its consideration of appropriate alternative strategies to suggest, should this occur.

The *previous model* holds similar information to the current model, but relates only to the first ten sentences of the session (up to point 14 on the interaction

---

8 The boundary of 3 for recording belief measures is a purely arbitratry decision. Investigation is required to determine when beliefs can be considered 'reliable'.

trace). At this stage only six attempts had been made at negative clauses, and of the last five, three were correct (indicated by the fact that two errors are listed). The system would predict the next sentence to be probably correct, but if it failed to find a match in the expert model, it would generate the the condition:

xS/negative/postV

and match with the mal-rule:

xS --> negative, verb, hyphen, pronoun.

The condition:

xS/negative/err

could generate only:

not(expert_rule),

since the actual error which occurred was not diagnosed.

For affirmative main clauses and infinitives the situations are similar to those described for the current model. Similarly, strategy information is recorded as in the current model.

Figure 5.1 shows in condensed form, which parts of the interaction provide confidence ratings for the current and previous models.

Sentence Type	System Evaluation	Student Belief	Model
negative	postV	c	
negative	postV	a	
negative	err	b	
negative	corr	b	
negative	corr	c	
negative	corr	b	
affirmative main clause	corr	b	
affirmative main clause	corr	a	
affirmative main clause	corr	a	
infinitive	contrac	b	
infinitive	corr	a	
affirmative main clause	change	b	
affirmative main clause	corr	b	
negative	corr	b	

key: ▬▬ previous model ▒▒▒▒ current model

Figure 5.1: information for belief measures in previous and current models

For the *current* model, the last 5 attempts for each rule are taken into account. For infinitives there are only 2 attempts available. For negative sentences there are 7, thus the first two are discarded. The learner changed her confidence measure for affirmative main clauses, therefore only this fact is considered in deciding the student's belief measure (though the system's will still be based on the usual amount).

The *previous* model is based on the interaction which occurred during the first 10 input sentences. Here there had been 6 attempts at negative sentences, so the first was discounted. There was only one attempt at an infinitive with pronoun, and there had been 3 tries at composing affirmative main clauses.

If B2 had chosen to view the current proficiency information at the end of the session, it would have appeared as follows:

	YOUR CONFIDENCE (a - d)	SYSTEM CONFIDENCE (1 - 4)
negative clauses: e.g. Não os compra	•almost sure (b)	•almost sure (2)
positive main clauses: e.g. Compra-os	•almost sure (b)	•very sure (1)
with infinitives: e.g. Quer comprá-los	• ___	• ___

B2 would have been likely to agree with the representations for negative clauses, since the confidence measures of herself and the system are equal. Given the result of the previous interaction about main clauses, she would probably have accepted the difference in confidence level (as she did not pursue this last time, after she had been 'defeated' during argumentation). B2 may have simply accepted the lack of information about infinitives, or she may have chosen to try another sentence of this type, in order to get some information into the student model.

Self (1991) warns that

> ILE interruptions to 'tell me what you are thinking' may well be counter-productive, since they will interfere with on-going cognitive activity.
>
> (Self, 1991:40)

The approach of Mr. Collins aims to promote reflection in such a way that interruptions will be less central, by creating situations in which the learner may take the initiative if he *wants*. Further, the system interventions of this kind that *do* occur are designed specifically to *enhance learning*.

Chapter 5 has illustrated Mr. Collins in use. In chapter 6 Mr. Collins is further discussed, including descriptions of contributions made to the field, and possible future work.

Chapter 6

Discussion and Conclusion

There are various methods which could be used to evaluate a student model, including:

- test the student (in the computational environment), and see whether the student model predicts the student's answer;
- ask the student what he thinks, and compare the model's prediction;
- run the student model and compare the result to the student's input.

In Mr. Collins, each of the above possibilities for evaluating a student model occurs during a normal interaction with the system. As the model can be discussed or negotiated, the student model can be said to be accurate if the student and system confidence measures are usually either identical or close. (There may be more variation for an individual learner who is not so effective at evaluating his own performance, but if the above statement holds true across most learners, the student model can be claimed to be accurate). Thus for *this* student model, there is an additional way in which it may be evaluated.

However, a full evaluation of Mr. Collins is currently not possible, since the student model is not yet embedded in a complete system. The problem of evaluation in this context is not that it cannot be done - it would be very easy to check, for example, whether student and system beliefs were on the whole compatible in the current implementation - however it would not be easy to do this in an authentic evaluation situation, as the system at present is not designed for use as a full learning environment. Nevertheless, since evaluation methods have been suggested, the validity of Mr. Collins is testable given the right conditions (though, of course, success will not be wholely dependent on the student model, but also on the teaching approach chosen to supplement the learner exploration currently implemented).

What has been achieved so far is the implementation of a student model which functions according to claims of (in this case) applied linguistics, by taking into account factors which influence acquisition of the domain. It has also been demonstrated that collaborative student modelling is computationally feasible; and furthermore, students understand and accept this approach in a (limited) system.

Since different student modelling techniques are not critical to the approach of this thesis - the approach of Mr. Collins can be combined with any kind of student model which is successful in its own context - Mr. Collins has not been systematically contrasted with other approaches. It is possible, however, to describe Mr. Collins in terms of user modelling classification schemes as a means of illustration. This occurs in section 6.1 below. Contributions of this thesis are summarised in section 6.2, and further work in section 6.3. Section 6.4 briefly introduces some of the current work which has resulted from the Mr. Collins student model. Finally, the thesis conclusion is given in section 6.5.

6.1 Where does Mr. Collins fit?

A useful way to summarise Mr. Collins will be in terms of Kok's user modelling classification scheme (Kok, 1991), to provide a general description of the purpose of the model, and how it functions to achieve this purpose. Kok uses eight dimensions under the four headings: 'why', 'who', 'what' and 'how', each section containing firstly a functional, and secondly a technical description. Kok's dimensions are as follows:

1. *Why are users modelled?*
   a. What is the overall aim of modelling users.
   b. Which parts of the system need user information.
2. *Who is modelled?*
   a. What is the role of the user being modelled in relation to the system.
   b. How individual are the user models, i.e. which and how many users are represented by a model.

3. *What is modelled?*
   a. What aspects of the user are meant to be represented by the user model contents.
   b. What is contained in the user models, and what are the interpretation methods of the contents.

4. *How are users modelled?*
   a. What are the methodologies of modelling and what are its sources.
   b. Which user modelling techniques are used.

Mr. Collins' position in terms of the above framework is as follows:

1a. The goal behind modelling the learner is to analyse his knowledge, beliefs and misconceptions, to enable an ILE to adapt effectively. The model is inspectable by the student, and negotiable; this having the additional, unusual role of prompting learner reflection.

1b. Parts of the system needing information about the user will vary depending on the goals and purposes of the individual learning environment. A further need for information relating to the user comes from the user himself (an aspect not accounted for in Kok's classification).

2a. The role of the user is that of student; someone intending to learn (some aspect of) the domain of the system, to which the student model is attached. The student is viewed as an equal partner to the system, and is expected to be an 'active' learner.

2b. The model is split: partly individual and partly general. In this implementation the learner's native and other foreign languages are represented as *universal knowledge* applicable to all speakers. An *individual model* of each learner is maintained to represent his actual beliefs, competence and approaches to learning, and to trace his learning history. However one part of this individual model is, in fact, canonical; there is a

universal representation of a user's future progression as this is the only way to make available a typical learner's prospective performance.

3a. Various aspects of the student are modelled explicitly: his knowledge level of the target domain; beliefs or confidence in particular areas; native and other known languages; learning strategy preferences; learning history and anticipated future performance.

3b Representations of the target language in the *intermediate* and *expert* models are in the form of grammar rules in DCG notation.

The information contained in the *historical* and *current* models for each rule comprises the total number of attempts, the student and system current[1] belief measures, and misconceptions identified in the last five attempts. Confidence is assigned on a four-point scale. Letters (a - d) represent the learner's confidence, and numbers (1 - 4) represent the system's beliefs about the learner.

The *historical*, *current* and *intermediate* models refer to a separate listing of mal-rules to use in conjunction with their own contents.

Other languages are represented as DCG rules, however there are no mal-rules included for background languages.

The names of learning strategies are asserted as they are used the first time, and the 'frequency property' of a strategy is incremented whenever it is used.

```
s --> neg, pronoun, verb.

negative(10,[a,2],[English=1,
Hyphen=1]).

xs --> neg, verb, pronoun.

engS --> neg, verb, pronoun.

student_model_evidence(self_
evaluation).
frequency(self_evaluation,12).
```

---

1 In a historical model, current means current *at that time*.

The interpretation methods of the contents of the model will depend on the particular ILE which uses it.

The view of the student model available to the student is different from the above; the information is modified and restructured to make it meaningful to the learner. E.g. - for the first case above (expert rule):

The pronoun is pre-verbal in negative clauses

Não os compra

4. 4a and 4b are combined here to allow the description to progress fluently through the student model continuum.

•

Different sections of the student model are constructed in different ways. Contents of the *learner profile* are obtained by asking the student to select components from a list provided by the system, leading to a stereotypical expert model of language background (but composed of individual language combinations), and individual model of learning strategy preferences (an overlay model in the sense that only the presence of a strategy is recorded). Contents relating to target language knowledge are obtained through testing the student. This is also represented as an overlay model.

The *historical representations* are obtained simply by copying the current model to the most recent historical model at regular intervals (currently after ten sentences are entered, and also when the user quits the application). Each previous model moves one place back, towards the learner profile. Research is still required to determine at which point a new model should be acknowledged; i.e. when is a change significant?

The *current model* is maintained in a number of ways. The system's student model of learner proficiency is obtained through system inferencing based on a learner's input, and also through questioning the student about his beliefs. The student's student model is maintained by learner statements of their confidence in their input. Some inferencing is also done by the system to determine what is the most likely overall student belief measure in cases where the student's confidence is continually fluctuating. The exact classification of this part of the model is difficult: two models are involved

(the system's and the student's) - each having features of a perturbation model. However, these models are at the same time belief models, since degrees of belief are also recorded. Some aspects of the model may be constructed by learners volunteering information at any stage, through menu selection. A final method of maintenance of the learner's and system's beliefs occurs through negotiation. The overall technique (of this perturbed, negotiated, belief model) has been termed *collaborative modelling*, for ease of reference.

Information about a learner's strategy use is obtained when the system traces the learner's actions in the system. This is not really inferencing, since the learner's actions are fact, and certain actions will necessarily be indicative of certain strategies. The technique is closer to the idea of deduction.

Representations of other languages known are (currently) drawn directly from the learner profile, since a learner is very unlikely to change their level of proficiency in another language during the time they use the present version of the Portuguese ICALL system.

The *intermediate models* and *expert model* are in the form of prestored stereotypical models. The expert model is, of course, the domain model. The intermediate models are overlay models, the size of the overlay on the expert model increasing with each successive model.

Figure 6.1 below illustrates the different kinds of structure that make up the various parts of the student model continuum.

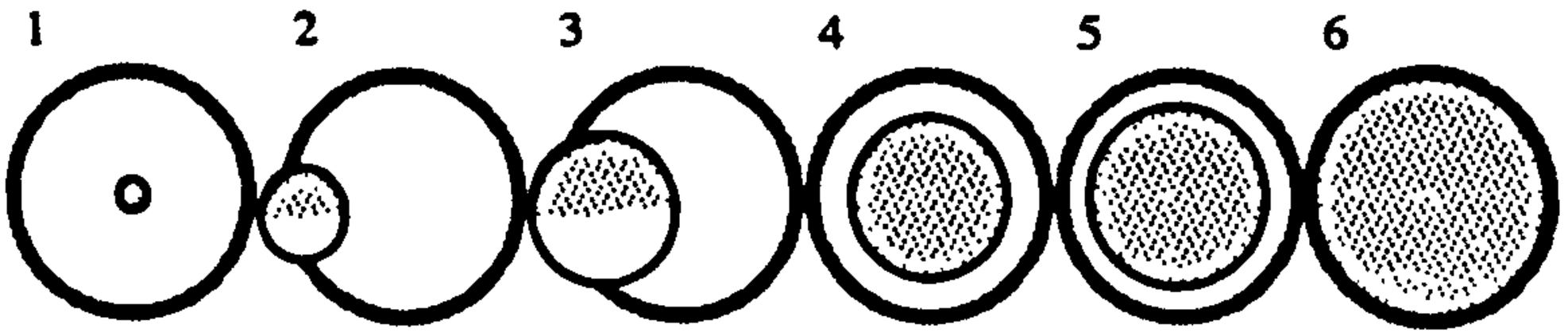

Figure 6.1: The Student Model Continuum V

The large outer circles represent the system's expert domain knowledge.

Model 1 is a graphical representation of the learner profile, the smaller inner circle depicting the restricted level of information contained about the student at this stage. The learner profile is a small overlay on a much larger area of knowledge. The information contained is the system's representation of the learner's knowledge.

Model 2 portrays a historical model; the student model itself has increased in size as more information is recorded. The model is no longer an overlay, but also includes representations of misconceptions (outside the domain model). The shaded area of the model represents the system's beliefs about the student, and the plain area, the student's own beliefs.

Model 3 is the current model. The form of the model is similar to that of the historical model, but the size of the model has increased, because the representations are by this time more detailed, and a broader range of information is included.

Models 4 and 5 are intermediate models. Since these are based on the typical acquisition sequence the models are overlays, and the representations are from the system's point of view. The overlay of model 5 is larger than that of 4 because a greater amount of the domain will have been acquired by the time the current model reaches this position. (When the current model reaches position 5 its structure will be as in 3, but with the semi-shaded circle enlarged.)

Model 6 is the expert domain model. The overlay has increased to the size of the target domain.

In addition to the structure of the student model as described here, in Mr. Collins the meta-level of reflection is very important. Therefore it is also necessary to consider other types of classification system in order to describe Mr. Collins fully. This will be done by looking at Dillenbourg and Self's (1990) *framework for learner modelling*, as this framework considers modelling from both the system's and student's point of view. Thus it is particularly suitable for describing Mr. Collins. Dillenbourg and Self's framework for describing student models is reproduced in figure 6.2.

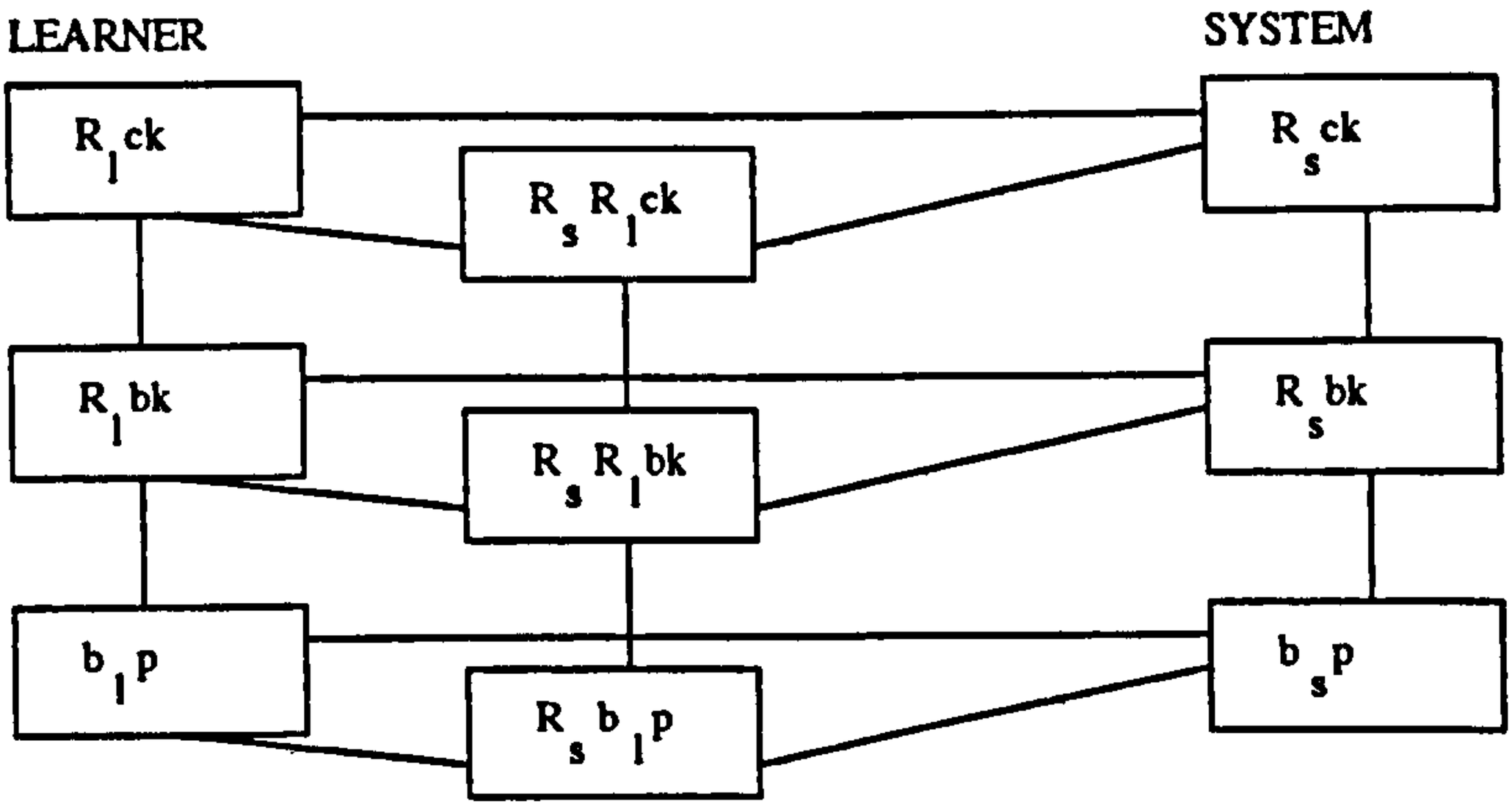

Figure 6.2: Dillenbourg and Self's framework for learner modelling

Key:

$R_s ck$ - the system's (representation of) conceptual knowledge

$R_s bk$ - the system's (representation of) behavioural knowledge

$b_s p$ - the system's behaviour on problem p

$R_l ck$ - the learner's (representation of) conceptual knowledge

$R_l bk$ - the learner's (representation of) behavioural knowledge

$b_l p$ - the learner's behaviour on problem p

$R_s R_l ck$ - the system's representation of the learner's (representation of) conceptual knowledge

$R_s R_l bk$ - the system's representation of the learner's (representation of) conceptual knowledge

$R_s b_l p$ - the system's representation of the learner's behaviour on problem p

Mr. Collins, through the unique collaborative approach, tries to get closer to the learner's real beliefs; i.e. to reduce the (inevitable) gap between the learner's beliefs and the system's representations of the learner's beliefs. In Dillenbourg and Self's terms, to move towards $R_l ck$: the learner's (representation of) conceptual knowledge and $R_l bk$: the learner's (representation of) behavioural knowledge.

Clearly, any representation is still going to be an RR (representation of a representation), but it is intended that by involving the learner in diagnosis it should be possible to move the middle column of figure 6.2 further to the left. Indeed, Mr.

Collins adds a further component as suggested by Dillenbourg and Self: R_lR_lck and R_lR_lbk. Thus the position of Mr. Collins in this framework is as in figure 6.3 below:

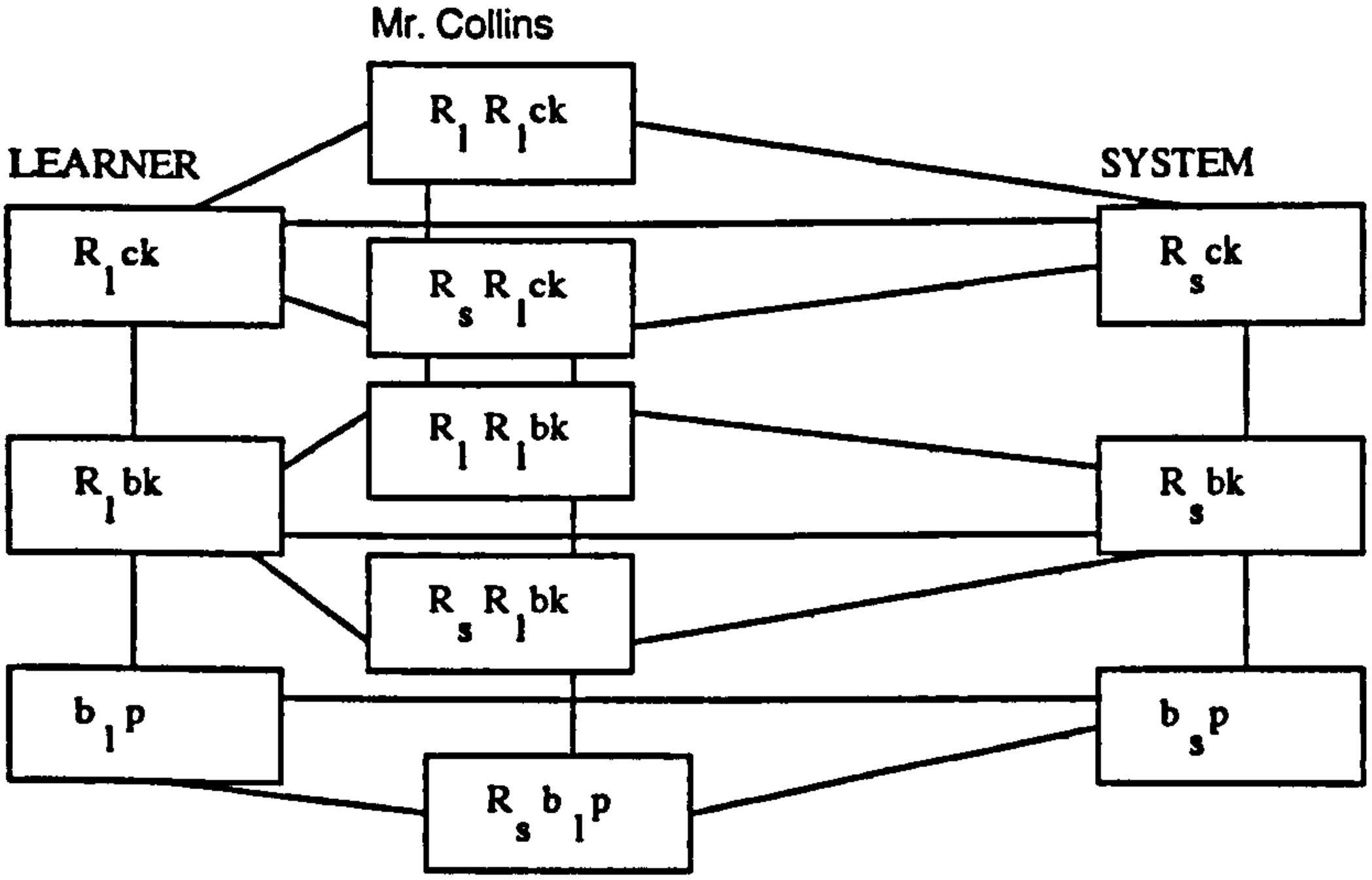

Figure 6.3: Mr. Collins in Dillenbourg and Self's framework for learner modelling I

There may be some debate as to whether the system's representation of the learner's knowledge (R_sR_lk) or the learner's representation of the learner's knowledge (R_lR_lk) should be closest to the left. However, as the aim of Mr. Collins is for R_sR_lck and R_lR_lck, and R_sR_lbk and R_lR_lbk to be(come) identical (i.e. $R_{sl}R_lck$ and $R_{sl}R_lbk$), these are portrayed here in the same vertical position.

In terms of reflection it is easier to describe Mr. Collins according to the above framework than with reference to Kok's classification of user models, as in this framework, the two sets of beliefs are represented explicitly. Figure 6.4 is an example of representations for negative and affirmative main clauses in the current models, as implemented in our ICALL system, presented through Dillenbourg and Self's framework.

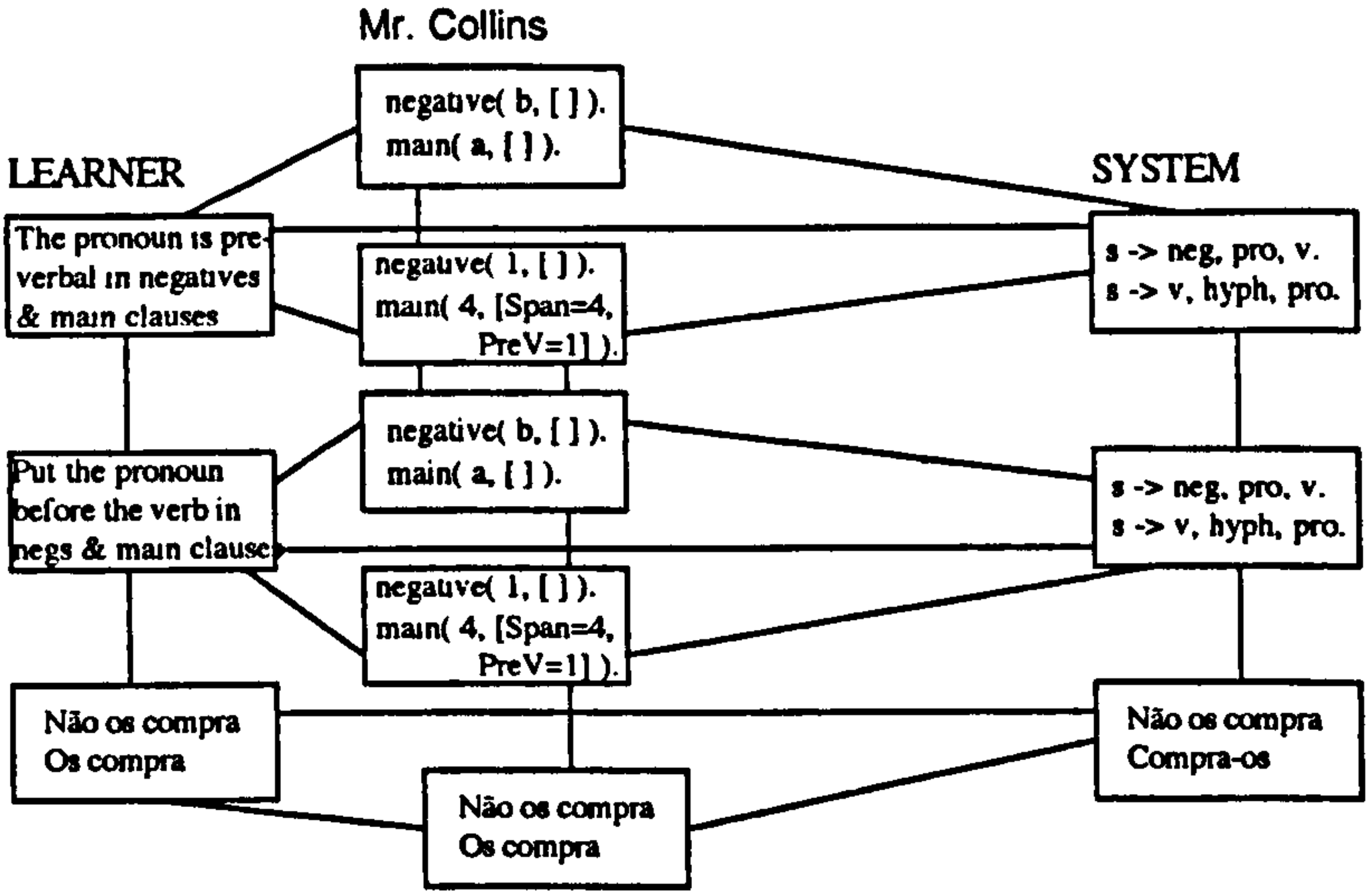

Figure 6.4: Mr. Collins in Dillenbourg and Self's framework for learner modelling II

In the current implementation there is no distinction in Mr. Collins between conceptual knowledge (ck) and behavioural knowledge (bk). This example shows that the system's domain knowledge of negative clauses matches the student's (though the student is less confident). However this is not the case for affirmative main clauses - the student believes that the pronoun should also be pre-verbal here, and is very confident of this 'fact'. The rule *negative(1,[])* allows the system to generate the sentence *não os compra*, which can be parsed by the expert domain rule *s --> negative, pronoun, verb* to verify the student's knowledge. In contrast, *main(4,[Span=4,preV=1)* can be used to generate the sentence *os compra*, parsable by the Spanish rule *spanS --> pronoun, verb*, or the general misconception rule *xs --> pronoun, verb*. Because it has a confidence measure of 4, the system can be very sure that an attempt at this type of sentence will be incorrect, and 4 occurrences of Spanish word order in the last 5 sentences indicate that this is probably due to Spanish influence, but may instead be overgeneralisation of the rule for negative clauses.

In more familiar terms, R_lR_lk and R_sR_lk would be viewed by the student as follows:

	YOUR CONFIDENCE (a - d)	SYSTEM CONFIDENCE (1 - 4)
negative clauses: e.g. Não os compra	•almost sure (b)	•very sure (a)
positive main clauses: e.g. Compra-os	•very sure (a)	•very unsure (4)

There is very clearly a discrepancy between the two standpoints for positive main clauses. By making the contents of Mr. Collins visible and negotiable, learners will more likely become aware of how their beliefs may differ from the system's perception of their beliefs. They will then be in a position to decide for themselves how to deal with any differences (e.g. argumentation; further exercises, etc.)

The two sets of belief measures are also invaluable to the system, since they help it determine how reliable it can consider the information to be. For example:

D4 indicates that the student is highly probable to be having difficulties, but that the student is *aware* of the problems.

A1 suggests that the system can be very sure of the student model contents: i.e. the student has mastered the rule.

A3, A4, B4, C1, D1, D2
advise that the system should regard the contents of the student model with some caution.

B2, C3, B3, C2
indicate that it is not possible to use the student model to predict a binary distinction between correct and incorrect input with complete accuracy (though if an error is made, it will be possible to anticipate what structures are likely to occur).

6.2 Contributions of Mr. Collins

The areas to which this thesis has contributed are applied linguistics and artificial intelligence in education. Although second language acquisition is only one of a number of domains that could benefit from the collaborative student modelling approach, because of the need to take account of how students learn the domain for this approach to be successful, the production of results for this field has necessarily occurred.

6.2.1 Error Types

In the limited area of personal object pronoun placement in European Portuguese, an analysis of error types made by students has been completed. Information has been produced as to the kinds of error, and to some extent also the frequency of different errors (though this will necessarily have been restricted by the contexts of the exercises). Individuals' combinations of error types have been recorded, and a comparison across learners made. The errors identified were classified according to the following groups: sentence structure; pronoun selection; phonetic contractions; hyphens; pronoun placement. It was found that there are a wide range of error types made by students, but patterns or combinations of particular errors were not predictable.

6.2.2 Language Transfer

Compared to research on native language transfer, there has been very little attention directed to transfer from non-native languages. This issue has been addressed to some extent in this thesis. Following Benson (1989), in the context of Portuguese it was found that learners exhibiting transfer tended to more often transfer from their non-native Spanish than from their native English. The need to consider non-native languages when dealing with transfer has been highlighted.

6.2.3 Acquisition Order of the Target Rules

Most work on acquisition sequences has focussed on broader areas of language. The aim in this thesis was not so much to determine what the acquisition

sequence for the rules of pronoun placement is, but a weaker version: might it be possible to identify tendencies in the order of acquisition of these rules, to the extent that this could be usefully used by a system in student modelling? A sequence was found for this purpose. Although contributing less to applied linguistics than the other areas of language considered, these results should still be useful to teachers of Portuguese.

6.2.4 Learning Strategies

Although there is no consensus in the literature as to the utility of strategy *training* in language learning, there does appear to be some evidence that knowledge about strategies can be beneficial. Thus a classification system has been developed which takes account of strategies used by students in determining what might be the most appropriate strategies to suggest next (in terms of a student *understanding* the strategies, and being able to judge their appropriacy for themselves), if they wish to investigate learning strategies further. This classification has been developed over a subset of the strategies identified by O'Malley and Chamot (1990).

6.2.5 Language Awareness

The main contribution to applied linguistics in the area of language awareness is in the design of CALL. The majority of approaches to CALL do not attempt to raise learner awareness. It is not clear whether this is simply not considered in the design of programs, or whether it is assumed to be too difficult to implement effectively. This thesis has demonstrated the possibilities available by taking the approach of designing a system which encourages the learner to view and question information not only about the domain, but also about his own learning in the domain.

6.2.6 Student Modelling

This thesis has shown that by taking into account factors such as the above, it is possible to include more detailed information in a student model about *how* learners learn their target domain. This will enable the creation of more accurate student models, where the contents can usually be seen to be closer to the learner's true state of knowledge. Furthermore, a new approach to modelling students has

been presented: *collaborative student modelling*. This approach has the benefit of including information in the model about what learners really think, and also encouraging learner reflection, and thus the student model can be used to directly contribute to learning. Initial experimentation has indicated that learners are in general both capable and interested in collaborating in the construction and maintenance of their student model.

6.2.7 Summary

Mr. Collins aims to demonstrate that there are useful roles for student models, beyond their conventional uses. By taking account of issues which affect a student's learning of their target domain, in addition to their individual level of knowledge in the applicable areas, it is possible to implement a student modelling approach which can use infromation traditionally not modelled, to help in diagnosis. In this thesis this has been illustrated in the domain of second language acquisition. Therefore contributions have been made to the field of applied linguistics, since the results used to inform the design of the student model were necessarily based on empirical studies. However, although only one domain has been used to date, there is a possibility of generalisation of Mr. Collins at the level of the framework. The issues considered for second language acquisition may have relevance in other domains, and indeed, there may be other areas to consider in different domains. The central factor is that one should consider what is important in the learning of the domain of the system.

Using such information it is possible to afford the student model the role of *learning resource*, since the availability of the additional information in the student model allows the system a position from which it may discuss the learner's progress with the learner himself. The major benefit of this facility is that it can be used to promote learner reflection by presenting information about what the student has done, and (implicitly) how this fits in with second language acquisition theory. The main contribution to the field of artificial intelligence and education is in the definition of a new approach to student modelling: one which encompasses domain issues and metacognition, the latter partly a result of consideration of the former.

6.3 Further Work

As always, there are many areas in which this thesis could be made stronger. This applies particularly in a thesis such as this, where various different theoretical approaches are integrated into one system. Each aspect could be improved through further research, and it is hoped that by identification of the following areas these issues will be taken up, and the philosophy behind Mr. Collins may be improved through specific investigations.

6.3.1 Error Analysis

The error data collected to inform the design of Mr. Collins, although more comprehensive than is usual for the design stage of CALL programs, could still be expanded. A large variation in error types was identified, but there are almost certainly other less frequent, but nevertheless persistent, kinds of error. Further, a broader corpus would enable the distinction between relative frequency of some of the rarer errors in the present data.

Of course, this discussion is only relevant to the current implementation of Mr. Collins. Indeed, continuing investigation of the problems encountered in the use of personal object pronouns by learners of Portuguese would be a fruitful area of consideration for applied linguists, since despite access to information regarding pronoun use, students consistently continue to use them incorrectly.

In relation to use of pronouns in written exercises, as occurred here, it would be useful to investigate this further in other contexts, e.g. comprehension; composition; speaking, etc.

Although obvious, it should probably also be mentioned here, for the sake of completeness, that language problems similar to those considered for this system should also be taken into account in the design of ICALL systems directed at other target domains.

6.3.2 Language Transfer

There are other issues besides L_2 proficiency and perception of language distance (as used here), which could be involved in transfer. Examples include: markedness (Eckman, 1977), proficiency in the target language (Taylor, 1975), beliefs about how best to learn a language, or the recency of learning a language from which cross-linguistic influence may occur. Such questions are outside the scope of the thesis, but should be considered if the two issues of proficiency in background languages, and perceived language distance, later prove inadequate predictors of the source of transfer in this context. Yet other possibilities include transfer of aspects of the learner's current 'inaccurate' target language interlanguage (as stated in Gass, 1988), and also divergent interlanguages of other foreign languages. These 'non-expert rules' are also not dealt with in the current version of Mr. Collins. Indeed, although this phenomenon may occur, there is a danger that discussion of transfer of 'inaccurate rules' from within one language, or from one language to another, could ultimately be confusing for the learner. Whether this would be problematic requires further investigation.

Although there are six levels of proficiency in a background language which are taken into consideration in Mr. Collins ('highly' fluent; (near) fluent; advanced; intermediate; patchy; beginner), there is only a two-way distinction between similar/dissimilar judgements of language distance. This should be increased to allow a finer distinction. For example, students may like to state that they consider Spanish to be very similar to Portuguese, French less so but nevertheless still similar, and English to be dissimilar - but not as dissimilar as Japanese.

As already stated in section 4.2.3, it is difficult to discriminate between some languages as potential sources of transfer if their respective parse numbers are close (see figure 4.9), unless we can verify that the specified combinations of similarity/perceived language distance are adequate. Further research therefore needs to be undertaken to discover whether a sufficiently reliable parse order can be determined, or whether languages assigned 'close' parse numbers should be considered equally likely to be the source of transfer. This could be investigated either by more traditional methods by applied linguists, or through use of the system itself, by analysing actual interactions. For example, until the system has been used by sufficient numbers of students with varying language backgrounds, it is not

possible to answer questions such as: is a non-native language known to intermediate level, and perceived as similar to the target more likely to be the source of transfer than a non-native language at advanced level, but which is perceived as dissimilar?

Mr. Collins handles, to a limited extent[2], transfer (and overgeneralisation or correct production) of all the rules described by Benson (1989; 1990 - see section 4.2.1), except for the case of gerunds. The system could be extended to take account of this final aspect (and could also be extended to provide more exercises for some of the rules which *are* covered).

By carrying out a survey of target users (see study 2, section 4.2.1), it was ensured that those languages most likely to be the source of transfer for most users were included in the system. However, there is always the possibility of 'unusual' users, and other languages could be considered for inclusion. Italian is such an example - the data obtained from study 2 was not conclusive. For example, it may be that some students refer to Italian when learning Portuguese.

As stated previously, the current implementation of Mr. Collins is in a restricted domain, and is intended as an *illustration* or *example* of a system which incorporates theoretical knowledge about language transfer (among other things), to aid learners in their acquisition of a foreign language. The generalisability of Mr. Collins is at the level of the framework and the issues involved. The system can therefore be used as the basis for the design of other systems with similar concerns; there are many other cases where it would be useful to consider multiple background languages as potential sources of transfer. For example, an obvious area to consider in different languages is the lexicon, as lexical influence appears to be the most common type of non-native cross-linguistic influence (Ringbom, 1987). Another possibility for our case of L_1 English, L_2 Spanish and L_3 Portuguese is the differing contrast between *ser* and *estar* in Spanish and Portuguese (Benson, 1989; 1990). A similar example for other languages is comparison between the use of English *do/make*, German *tun/machen* and Dutch *doen/maken* (described in Nehls, 1991). Word order difficulties may arise, for example across some Germanic languages (e.g. Platzack (1986) illustrates some differences in the ordering of the infinitival marker, infinitival verb and sentence adverbial in infinitival phrases in

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2 For demonstration purposes, although twelve rules are implemented, exercises and multilingual examples and comparisons for most of these are quite limited. Two rules are handled in more detail: negative clauses and affirmative main clauses.

Scandinavian languages, and also describes similarities and differences of word order in normal subordinate clauses between German and Dutch, which differ from Danish, Norwegian and Swedish, which, in turn, differ from English and Icelandic). Although the simple existence of such similarities and differences neither guarantees transfer, nor implies that transfer will be probable, it is nevertheless possible that a knowledge of some combination of these languages could influence a student, and could also be used by an ICALL system to help a student in his learning of a further language from this group.

6.3.3 Acquisition Sequence

The acquisition sequence identified for this version of Mr. Collins is still very tentative. For this particular implementation it would be useful to discover exactly to what extent this (or a variation of this) ordering can be relied upon. In addition, it would be beneficial to undertake a longitudinal study of acquisition to help confirm (or disconfirm) the results achieved so far.

For other language implementations of Mr. Collins, it would be similarly useful to investigate the appropriate linguistic areas to discover whether a useable sequence can be identified. Should this occur, it would be interesting to compare different implementations of acquisition orders in ICALL systems to see whether any one approach to integrating the sequence appears more effective (e.g. use of an acquisition sequence to aid diagnosis - as here; teaching according to the sequence).

6.3.4 Learning Strategies

Although cover of learning strategies and issues connected with learning strategies is quite comprehensive in Mr. Collins, there are still some remaining questions. For example, might it be easier to predict learning strategy use and/or suitable learning strategies depending on a learner's beliefs about language learning? If this were true, instead of requesting students to state their strategy use (after viewing the information provided) for the learner profile, the profile could be constructed directly from their (stated) beliefs. This may be easier for students, and is therefore an issue which requires further investigation. It may be that some students are initially more easily able to state their beliefs, and others may prefer to describe their strategies. Perhaps both aspects could be incorporated into the system.

There are other issues which may affect learning strategy use, for example motivation, age, proficiency (Skehan, 1989; Oxford, 1993); type of task, learning style (Oxford, 1993); cultural background (Oxford, 1993; Awang Hashim & Syed Sahil, 1994; Politzer & McGroarty, 1985); learning environment (LoCastro, 1994, 1995); gender (Oxford, 1993; Awang Hashim & Syed Sahil, 1994); aptitude (Skehan, 1989). Clearly if any of these factors are good predictors of natural strategy choice, this information could be usefully incorporated into the system. However it is not clear whether students would actually welcome interaction on some of these issues, e.g. age, cultural background, gender.

Wenden (1991b) suggests a hierarchical relationship between metacognitive and cognitive strategies (in L_2 writing). The use of metacognitive strategies may influence the choice of cognitive strategies. This could be a useful direction for future research, and for a future, more extensive ICALL system.

The order in which strategies are introduced should also take account of the order of emergence of strategy use, if this can be identified. Such an order is described in Chesterfield and Chesterfield (1985), however this data is for very young children. It may apply to a lesser extent to adult learners. Skehan (1989) notes some correlation between this and frequency of use data (as described in O'Malley et al, 1985a). We have already seen that following an acquisition order can be useful in relation to the target rules. If a clear, natural and useful sequence of emergence of strategy use could be identified, this could no doubt be beneficially included in the system. Whether it is indeed the case that such a sequence can be sufficiently determined, and that it can be successfully used in the ICALL environment, requires further investigation.

An interesting future direction would be for the system to actually model to students the use of the learning strategies it discusses. This occurs currently (and without explicit reference) with only a few of the strategies (see section 4.4.1).

Another question is whether the interface, interaction, or presentation of information from the student model and other sources could be usefully varied depending on which learning strategies are preferred by a student (or, if such aspects were to be varied, whether this would work better based on direct student choice

rather than system inference from learning strategy use). As the current research is concerned primarily with student modelling itself, and not on system adaptations resulting from variations in student models, we are not yet ready to consider this issue.

Finally, information obtained from students' use of the system could be used to provide information to those researching learning strategy use. Extensive data on individual strategy use, typical strategy groupings, and the success of introduction of new strategies depending on those already used, could be very easily collected as the system records all strategy use, and also strategy choice and rejection by students. Clearly, such information could also be usefully employed to refine future versions of this, and other systems.

6.3.5 Awareness

Awareness-raising in the current implementation should occur through a combination of explicit statements of rules; inspectability of the student model; possibilities of discussion; and the overall transparency of the system. There are many ways in which such an approach could be extended, for example by the introduction of more complex exercises demanding more reasoning on the part of the student; by requiring the student himself to define rules, and so on. Other variations include using a similarly transparent ILE to help encourage peer interaction - i.e. to encourage collaborative learning and explanation between students. Also beneficial to this approach would be to investigate varying the formats of presentation of information to the student(s), according to what is most effective for each case. See section 6.5 for brief descriptions of the early stages of projects to address some of these issues. A further question is: just how much information about their learning should be given to a student? To what extent does this depend on the student's stated preferences, or individual approaches to the task?

6.3.6 Collaborative Student Modelling

The current implementation has been designed for, and tested on domain novices. Future work would include evaluating the approach with more advanced learners, to determine whether their reactions are similar.

As stated in the previous section, a comparison of different methods of making the student model explicit would also be useful. In addition, alternative methods of less direct challenge from the system may be considered for Mr. Collins (or similar approach), for use by learners who are less comfortable with the explicit approach. Another issue for investigation is to what extent should the system 'encourage' a student to view the student model when they seem reluctant to do so? How often, or at what points should the system interrupt the interaction to initiate discussion?

Further questions include: will (some) students eventually get fed up with always having to state their level of confidence? Given probable options, what degree of variation is there amongst students in their ability to identify their own beliefs? I.e. can we assume that the types of student for which Mr. Collins has been developed are the same as those who are capable of and enjoy performing this kind of analysis?

Collaborative maintenance of the student model occurs through menu selection and answering questions (for the student's contributions). It has been assumed that natural language is inefficient or ineffective for this kind of task. However, it would be very interesting to consider the possibilities of a natural language approach for related work. This could probably not be used as a major basis for student modelling, but by extracting information from the model, and by discussing students' beliefs with the students where they are able to use their own words, it may be possible to obtain information for the teacher or researcher, in order that they may learn more about students' conceptualisations. Hence students' needs may be better addressed through both conventional teaching and more 'understanding' ILEs. By explaining his views to an apparently comprehending system, the student is likely to reflect more on his knowledge.

There is, as yet, no proper definition of negotiation used for Mr. Collins; this aspect of the system is still rather ad hoc. The aim of the work was to show the *potential* of the approach. Although the current implementation appears to function as expected, and it seems that the approach it is nevertheless very limited. It is now time to investigate more fully *how* negotiation for collaborative student modelling should be implemented.

Section 6.3 has offered some suggestions for useful research in the areas of concern of this thesis. In addition to the above descriptions, in terms of the most efficient method for representing these issues in the student model it remains necessary to in some way test each part of the approach independently. This will provide guidelines for which aspects of the approach are most useful in aiding diagnosis, e.g. should more attention be given to a learner's background languages or to the acquisition sequence, or to the Portuguese error corpus, when trying to define misconceptions? Or should the main source of information be the collaborative interactions with the student? Should the system be more trusting of the student, and less trusting of general linguistic theory in individual cases? The various approaches have been combined in Mr. Collins, but much work remains before the overall approach can be perfected.

6.4 Where has Mr. Collins gone?

Section 6.2 described work remaining on the Portuguese pronoun, and second language acquisition system in which Mr. Collins is currently embedded. This section briefly describes some of the current work resulting from collaborative student modelling and Mr. Collins, as an indication of where the work has led. The projects to be described are not actually part of this thesis, but have emerged to varying extents from it. The purpose here is to illustrate that as well as contributing to the fields of student modelling and second language acquisition, Mr. Collins has also fed into the areas of human-computer interaction; collaborative learning; peer tutoring; use of feedback, and assessment.

The MSMSS System

MSMSS (Multiple Student Models for Single Students), according to the current (early and evolving) design, will be a system with multiple tools for viewing the student model in different presentation formats (e.g. textual, tabular, various graphical representations, use of colour). The aim is to discover whether certain types of presentation are more useful; whether this varies according to task or individual students; whether students are able to themselves select the best kind of presentation for them, if given the choice; and whether it may be useful to combine presentation formats in some cases.

The 2SM System

Work on the 2SM system is further advanced. 2SM is a system designed to encourage peer tutoring by providing two student models within one system, relating to two students using the system. It is expected that where the contents of the two (inspectable) models differ, spontaneous peer tutoring will occur. This did indeed happen in a modified pen and paper version of this process, where students who had separately completed a (language) task came together to compare their answers. Although not explicitly instructed to teach each other, tutoring still occurred. Moreover, there were in most cases improvements in performance at the second stage, as compared to the first. Implementation of 2SM, based on the results of the pen and paper pilot, has commenced.

'See Yourself Write'

'See Yourself Write' is a system with two components, currently being used with undergraduate foreign language students. The first component is a template for tutors to provide feedback to their students on their writing, and the second, a student model which is automatically constructed for each student based on the feedback given by the teacher. The student model holds feedback given to students across several assignments, and provides an individual evaluation of their performance. The model is designed to be viewed by students, to prompt them to reflect on, and use the feedback received.

Collaborative Assessment

The collaborative assessment project is a more ambitious project aimed at involving learners more actively in their assessments, by having them negotiate their student model in order that this becomes the final object of a mutually agreed assessment. An empirical study of a human-human collaborative assessment process has provided some data for consideration for the design of the system. This initial work was performed by, and is described in Pain et al (1996).

6.5 Summary and Conclusions

This thesis has argued for a more central role for the student model in intelligent learning environments, in the form of a collaboratively constructed and collaboratively maintained student model. The benefits of this new *collaborative student modelling* approach are both in the improved accuracy of the model due in part to learner input to the modelling process, and the increased reflection and improved learning which should result from student viewing of, and discussion about their student model. Furthermore, in addition to learner input about their beliefs contributing to a more accurate model, diagnosis can be improved by also taking account of issues typically affecting learning of the target domain. Factors contributing to the modelling process are as given in figure 6.5 below.

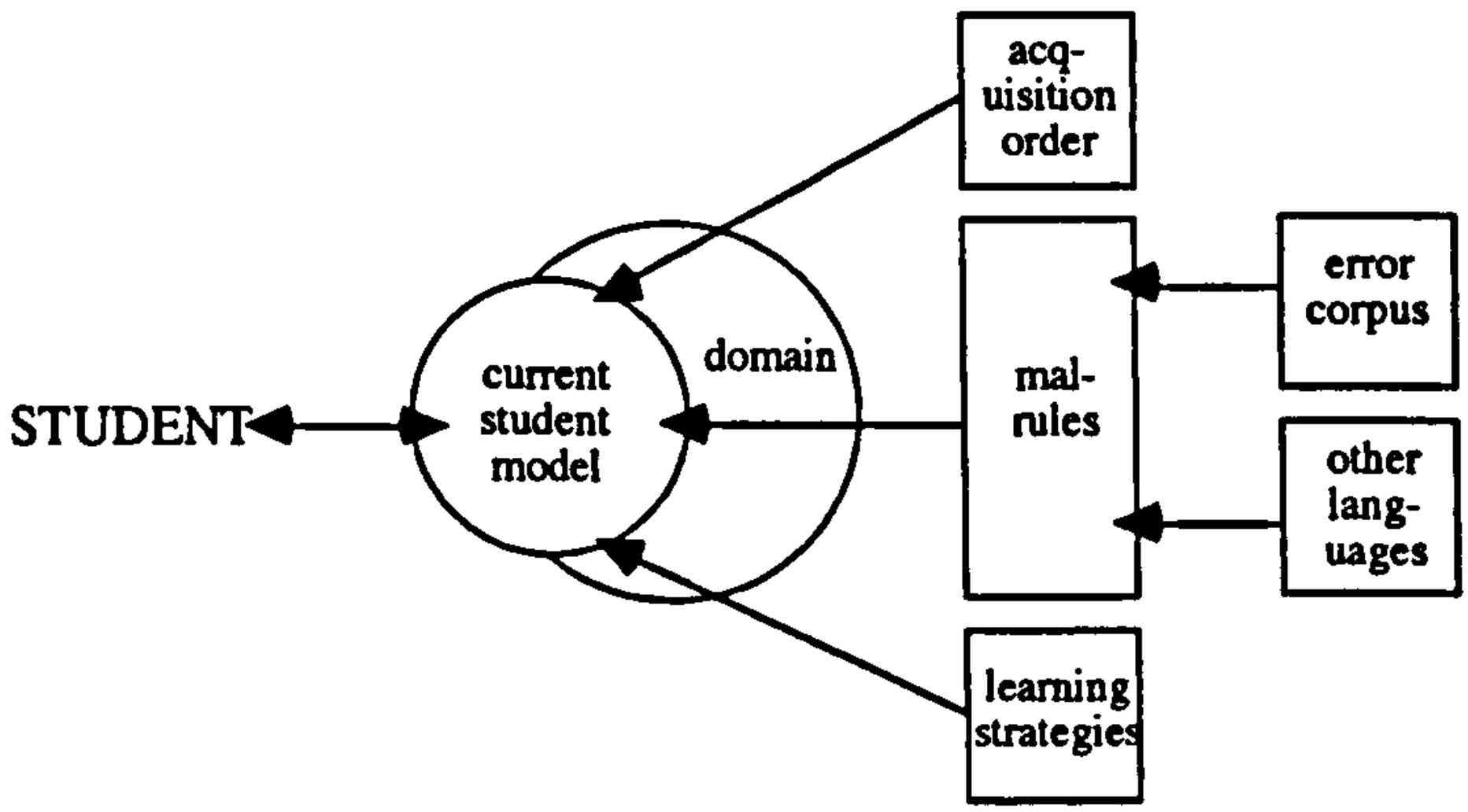

Figure 6.5: information sources for Mr. Collins

Mr. Collins does not favour any particular student modelling technique, though it must use a belief model of some sort, and requires more than a simple overlay model.

Information for the current student model is obtained from a variety of sources. The most usual of these (as compared with other student models), is a set of mal-rules. However, it is not the mal-rules themselves which are important in this implementation - Mr. Collins could be combined with any approach to student

modelling which is effective in its own context - but the fact that the mal-rules have been based on empirical data. This is, of course, not a new approach, but it is fundamental for a student model claiming to take account of what students are known to really do. The mal-rules are drawn from two sets of information: the Portuguese error corpus (e.g. xS --> negative, pronoun, hyphen, verb), and representations of the equivalent rules in other languages (e.g. engS --> negative, verb, pronoun).

More unusual features informing the Mr. Collins student model are firstly, the typical acquisition sequence of the target rules (e.g. 1: negatives; 2: open questions; 3: affirmative main clauses...), and secondly, learning strategy use[3] (e.g. transfer; deduction; inferencing).

The final novel feature of Mr. Collins is the collaboration between the system and student in the maintenance of the model. This provides a further perspective from which the system can gauge the student's knowledge and misconceptions, and at the same time promotes learner reflection on the domain and on their own learning process. This is a function rarely attributed to a student model.

These approaches have been integrated, and have been shown to function together. In addition to the computational feasibility of the approach, feasibility in terms of student acceptance has also been demonstrated. The existing implementation is not intended to be a full learning environment, hence the difficulty in running a complete evaluation at this stage. However, the research described in this thesis has brought us to a position where variations of the approach may be tested, in order to discover the best ways to continue with collaborative, in depth, student modelling.

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3 Although all strategy use is represented in the student model, because the current implementation is not inside a full ILE, this learning strategy information is at present used only to a limited extent (i.e. to suggest appropriate new strategies to an individual, and to provide the learner with information about his own strategy use).

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Appendix A

Previously published descriptions of Mr. Collins

Susan Bull
PROMOTING EFFECTIVE LEARNING STRATEGY USE IN CALL
Computer Assisted Language Learning Journal, in press

Susan Bull & Matt Smith
USING TARGETED NEGOTIATION TO SUPPORT STUDENTS' LEARNING
Proceedings of International Conference on Computers and Education, 1995, pp 173 - 181

Susan Bull & Helen Pain
'DID I SAY WHAT I THINK I SAID, AND DO YOU AGREE WITH ME?': INSPECTING AND QUESTIONING THE STUDENT MODEL
Proceedings of World Conference on Artificial Intelligence and Education, 1995, pp 501 - 508

Susan Bull, Paul Brna & Helen Pain
EXTENDING THE SCOPE OF THE STUDENT MODEL
User Modelling and User Adapted Interaction, vol. 5, no. 1, 1995, pp 45 - 65

Susan Bull, Helen Pain & Paul Brna
MR. COLLINS: A COLLABORATIVELY CONSTRUCTED, INSPECTABLE STUDENT MODEL FOR INTELLIGENT COMPUTER ASSISTED LANGUAGE LEARNING
Instructional Science vol. 23, nos. 1-3, 1995, pp 65 - 87

Susan Bull
HANDLING NATIVE AND NON-NATIVE LANGUAGE TRANSFER IN CALL: THEORY AND PRACTICE
in R. Wakely, A. Barker, D. Frier, P. Graves & Y. Suleiman (eds), Language Teaching and Learning in Higher Education: Issues and Perspectives, in association with CILT, London, 1995, pp. 97 - 108

Susan Bull, Helen Pain & Paul Brna
STUDENT MODELLING BEYOND DOMAIN KNOWLEDGE
Proceedings of International Conference on User Modeling 94 (UM94), Hyannis, MA, August 1994, pp 197 - 204

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LEARNING LANGUAGES: IMPLICATIONS FOR STUDENT MODELLING IN ICALL
ReCALL vol. 6, no. 1, May 1994, pp 34 - 39

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Computers and Education vol. 23, no. 1/2, 1994, pp 13 - 20

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GOAL-ORIENTED SOFTWARE: WHEN THE DEVELOPMENT PROCESS IS DIFFERENT...
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Susan Bull, Helen Pain & Paul Brna
STUDENT MODELLING IN AN INTELLIGENT COMPUTER ASSISTED LANGUAGE LEARNING SYSTEM: THE ISSUES OF LANGUAGE TRANSFER AND LEARNING STRATEGIES
Proceedings of the International Conference on Computers in Education, Taipei, Taiwan, December 1993, pp 121 - 126

Susan Bull, Helen Pain & Paul Brna
COLLABORATION AND REFLECTION IN THE CONSTRUCTION OF A STUDENT MODEL FOR INTELLIGENT COMPUTER ASSISTED LANGUAGE LEARNING
Proceedings of the Seventh International PEG Conference, Edinburgh, July 1993, pp 48 - 56

Susan Bull
TOWARDS USER/SYSTEM COLLABORATION IN THE DEVELOPMENT OF A STUDENT MODEL FOR INTELLIGENT COMPUTER ASSISTED LANGUAGE LEARNING
ReCALL No. 8, May 1993, pp 3 - 8

Appendix B

Empirical study into pronoun errors: STUDY 7 and STUDY 8

Appendix B is divided into five parts.
It shows the components of empirical studies into pronoun errors committed by first year undergraduate beginning students in Portuguese.
Parts I - IV are from STUDY 7 of the thesis, and part V is STUDY 8.

I	Exercise sentence and correct answer.
II	Test as received by students. (Each student received the test questions in a different random order.)
III	Rules and examples received after completion of the test.
IV	Correction sheet.
V	Feedback received by 4 of the subjects, and questionnaire responses relating to the causes of their errors.

II	Test Exercise Sentence	Correct Answer
1.	Não tenho comigo. (os)	[Não os tenho comigo.]
2.	Não comerei amanhã. (o)	[Não o comerei amanhã.]
3.	Quando visitas? (as)	[Quando as visitas?]
4.	Quem ensina hoje? (os)	[Quem os ensina hoje?]
5.	Os fabricantes vendem nesta loja. (os)	[Os fabricantes vendem-nos nesta loja.]
6.	Dão ao teu amigo. (o)	[Dão-no ao teu amigo.]
7.	Abre agora! (a)	[Abre-a agora!]
8.	Vende! (as)	[Vende-as!]
9.	Amanhã queremos escrever. (lhe)	[Amanhã queremos escrever-lhe]
10.	O António vai trazer agora. (a)	[O António vai trazê-la agora]
11.	Assim faz todos os dias. (o)	[Assim o faz todos os dias]
12.	Já disse a verdade. (lhe)	[Já lhe disse a verdade]
13.	Queres comer? (o)	[Queres comê-lo?]
14.	A Ana deu o livro? (lhe)	[A Ana deu-lhe o livro?]
15.	As raparigas verão no cinema. (o)	[As raparigas vê-lo-ão no cinema]
16.	A mulher decidirá por ir. (se)	[A mulher decidir-se-á por ir]
17.	No teu caso, comprava. (o)	[No teu caso, comprá-lo-ia]
18.	O Manuel e o seu filho diriam mais tarde. (lho)	[O Manuel e o seu filho dir-lho-iam mais tarde]
19.	A Maria espera que encontres com o professor. (te)	[A Maria espera que te encontres com o professor]
20.	O professor viu que lias. (o)	[O professor viu que o lias]
21.	Eu conheço o rapaz que comeu. (os)	[Eu conheço o rapaz que os comeu]
22.	O patrão viu o empregado que trouxe. (o)	[O patrão viu o empregado que o trouxe]
23.	O rapaz tem aberto. (a)	[O rapaz tem-na aberto]
24.	Tens visto. (o)	[Tem-lo visto]
25.	Não quero ver. (o)	[Não quero vê-lo]

II Please rewrite each sentence placing the pronoun in brackets into the correct position, and also make any phonetic contractions required.

Name: _____

How confident are you about your answer? Please tick appropriate box:

very sure	almost sure	unsure	very unsure

1. Não tenho comigo. (os)

2. Não comerei amanhã. (o)

3. Quando visitas? (as)

4. Quem ensina hoje? (os)

5. Os fabricantes vendem nesta loja. (os)

6. Dão ao teu amigo. (o)

7. Abre agora! (a)

8. Vende! (as)

9. Amanhã queremos escrever. (lhe)

10. O António vai trazer agora. (a)

11. Assim faz todos os dias. (o)

12. Já disse a verdade. (lhe)

13. Queres comer? (o)

14. A Ana deu o livro? (lhe)

15. As raparigas verão no cinema. (o)

16. A mulher decidirá por ir. (se)

17. No teu caso, compraria. (o)

18. O Manuel e o seu filho diriam mais tarde. (lho)

19. A Maria espera que encontres com o professor. (te)

20. O professor viu que lias. (o)

21. Eu conheço o rapaz que comeu. (os)

22. O patrão viu o empregado que trouxe. (o)

23. O rapaz tem aberto. (a)

24. Tens visto. (o)

25. Não quero ver. (o)

III

Examples

The pronoun is:

1. post-verbal in affirmative main clauses. (Compra-os)
2. post-verbal with positive imperatives. (Compra-os!)
3. post-verbal with infinitives. (Quer comprá-los)
4. post-verbal in yes/no questions. (Compra-os?)
5. pre-verbal in open questions. (Quem os compra?)
6. pre-verbal in negative clauses. (Não os compra)
7. pre-verbal in subordinate clauses. (Sei porque os compra)
8. pre-verbal in relative clauses. (Vejo o homem que os compra)
9. pre-verbal in certain adverbial phrases. (Também os compra)
10. infix in future tense. (Comprá-los-á)
11. infix in conditional tense. (Comprá-los-ia)
12. between auxiliary and past participle in main clauses. (Tem-nos comprado)

13. Note: pronouns always precede the verb in combination with negatives (eg. Não os comprará).
14. Note: the pronoun can never be the first word in a sentence.

IV If you wish to alter any of your answers after seeing the list of rules, please do so *on this sheet.*
Please do *not* change anything on the first sheets.

Question number:		Which rule prompted you to change your answer?
1.	_____	____
3.	_____	____
5.	_____	____
6.	_____	____
7.	_____	____
8.	_____	____
9.	_____	____
10.	_____	____
11.	_____	____
12.	_____	____
13.	_____	____
14.	_____	____
15.	_____	____
16.	_____	____
17.	_____	____
18.	_____	____
19.	_____	____
20.	_____	____
21.	_____	____
22.	_____	____
23.	_____	____
24.	_____	____
25.	_____	____

V

Portuguese Pronoun Test

S3

Your original score for pronoun placement was 19/25. After consulting the list of pronoun placement rules, you scored 21/25.

<u>Your difficulties of word order with pronouns were with the following sentences:</u>

3. A mulher decidir-se-á por ir.
You wrote: *A mulher se decidirá por ir.*
You have placed the pronoun in pre-verbal position. This is incorrect, because in an affirmative main clause statement the pronoun should usually be post-verbal. However, in this case the future tense is used, which means that a pronoun which would normally occur post-verbally becomes an infix (see rules 1/10).

5. O Manuel e o seu filho dir-lho-iam mais tarde.
You wrote: *O Manuel e o seu filho diriam-lho mais tarde.*
You have placed the pronoun after the verb. This is incorrect, because although in an affirmative main clause statement the pronoun is usually post-verbal, in this case the conditional tense has been used which means that a pronoun which would normally occur post-verbally becomes an infix (see rule 11). Your error could be a result of overgeneralisation of rule 1, or you may not have realized that 'diriam' is a conditional form.

6. Tem-lo visto.
You wrote: *Tens visto-o.*

11. O rapaz tem-na aberto.
You wrote: *O rapaz tem aberto-a.*
You have placed the pronoun after the past participle. This is incorrect, because the pronoun should be attached after the auxiliary.
After seeing the list of rules you rewrote both sentences placing the pronoun in the correct position (though you had some difficulty with the phonetic contraction in 6).

13. No teu caso, comprá-lo-ia.
You wrote: *No teu caso, o compraria.*
You have placed the pronoun in pre-verbal position. This is incorrect, because in an affirmative main clause statement the pronoun should usually be post-verbal. However, in this case the conditional tense is used, which means that a pronoun which would normally occur post-verbally becomes an infix (see rules 1/11).

21. Amanhã queremos escrever-lhe.
You wrote: *Amanhã lhe queremos escrever.*
You have associated the pronoun with the wrong verb. The pronoun should follow the infinitive.

Your problems with phonetic contractions were with the following sentences:

6. Tem-lo visto.
You wrote: *Ten-lo visto.*[1]
This is a very easy mistake to make! You have remembered to remove the 's', but in Portuguese words may not end in 'n', therefore this new final 'n' must change to 'm'.

Positioning in different types of sentence

There were 12 different sentence types represented in the test, accounting for 24 of the 25 questions. These are as presented in the list of pronoun placement rules provided for the second part of the test. Your score for pronoun placement (ignoring any problems of phonetic contractions) for each of these sentence types is presented below. (The maximum for each is 2.) The first score relates to the first part of the test, and a second score is provided if there is any change after viewing the rules.

negative clauses:	2	
open questions:	2	
affirmative main clauses:	2	
positive imperatives:	2	
infinitives:	1	
certain adverbial phrases:	2	
yes/no questions:	2	
future tense:	1	
conditional tense:	0	
subordinate clauses:	2	
relative clauses:	2	
auxiliary and past participle:	0	(2)

---

1 This second version of sentence 6 was given in the second part of the test (see Biii& Biv).

S3

We hope the test and this feedback has been useful for you. It would be very helpful to us if you could find time to answer (all or just some of) the following questions about your test, though of course, you are under no obligation to do so. You may answer anonymously if you prefer. (Even answers such as 'don't know' are useful.) If you are able to help, please return the questionnaire in the envelope provided. Thank you.

****

Question 3

Did you believe that the pronoun comes before the verb in future sentences? *No.*
Did you realise that this was the future tense? *Yes.*
Any other comments? *I thought reflexive pronouns cannot be infix. That is why I placed it before the verb.*

Question 5

Did you believe that the pronoun comes after the verb in conditional sentences? *No.*
Did you realise that this was the conditional tense? *Probably not.*
If not, what tense did you think it was? *I might have thought it is the imperfect.*
Did you assume the rule used in positive main clause statements was applicable?
Any other comments?

Questions 6/11

Can you explain why you placed the pronoun after the past participle?
I didn't know the rule which says that the pronoun goes between the auxiliary and the past participle.
Any other comments?

Question 13

Did you believe that the pronoun comes before the verb in conditional sentences? *No.*
Did you realise that this was the conditional tense? *Yes.*
Any other comments?
I placed the pronoun before the verb because I thought "No teu caso" applies to rule VI in our grammar notes[2]*:*
"Where the subject of a verb is expressed before it in such a way as to draw particular attention to it, the object pronoun will always precede the verb."
But now I realise that this cannot be, because tu is not the same as eu.

---

2 Frier (1992).

Question 21

Did you believe specifically that the pronoun is not attached to the infinitive? *No.*

Any other comments?

I thought the "amanha" might be the reason for placing the pronoun before the verb[2]:

"When a sentence begins with certain adverbs which are placed first in order to highlight their meaning, the object pronoun will always precede the verb."

****

Question 6

Why did you write 'ten-lo visto' instead of 'tem-lo visto'?

I was not sure whether a word could end in "n" or not!

****

Did you compare the Portuguese rules to any other languages? *No.*

If so, which languages?

Was thinking about the above questions useful or interesting to you in any way?

Yes, I think they helped me to understand the causes of my mistakes better.

Portuguese Pronoun Test

S9

Your original score for pronoun placement was 21/25. After consulting the list of pronoun placement rules, you scored 25/25.

Your difficulties of word order with pronouns were with the following sentences:

7. O Manuel e o seu filho dir-lho-iam mais tarde.
You wrote: *O Manuel e o seu filho diria-lho mais tarde.*
You have placed the pronoun after the verb. This is incorrect, because although in an affirmative main clause statement the pronoun is usually post-verbal, in this case the conditional tense has been used which means that a pronoun which would normally occur post-verbally becomes an infix (see rule 11). Your error could be a result of overgeneralisation of rule 1, or you may not have realized that 'diriam' is a conditional form.
After seeing the list of rules you rewrote this sentence placing the pronoun in the correct position (though there were some problems with the phonetic contraction).

16. Tem-lo visto.
You wrote: *Tens visto-o.*
You have placed the pronoun after the past participle. This is incorrect, because the pronoun should be attached after the auxiliary.
After seeing the list of rules you rewrote this sentence placing the pronoun in the correct position (though there were some problems with the phonetic contraction).

20. As raparigas vê-lo-ão no cinema.
You wrote: *As raparigas verá-no no cinema.*
You have placed the pronoun after the verb. This is incorrect, because although in an affirmative main clause statement the pronoun is usually post-verbal, in this case the future tense has been used which means that a pronoun which would normally occur post-verbally becomes an infix (see rule 10). Your error could be a result of overgeneralisation of rule 1, or you may not have realized that 'verão' is a future form.
After seeing the list of rules you rewrote this sentence placing the pronoun in the correct position (though there were some problems with the phonetic contraction).

23. No teu caso, comprá-lo-ia.
You wrote: *No teu caso, o compraria.*
You have placed the pronoun in pre-verbal position. This is incorrect, because in an affirmative main clause statement the pronoun should usually be post-verbal. However, in this case the conditional tense is used, which means that a pronoun which would normally occur post-verbally becomes an infix (see rules 1/11).
After seeing the list of rules you rewrote this sentence correctly.

Your problems with phonetic contractions were with the following sentences:

1. Dão-no ao teu amigo.
You wrote: *Dá-no ao teu amigo.*
7. O Manuel e o seu filho dir-lho-iam mais tarde.
You wrote: *O Manuel e o seu filho diria-lho mais tarde.*

9. O rapaz tem-na aberto.
You wrote: *O rapaz te-no aberto.*
20. As raparigas vê-lo-ão no cinema.
You wrote: *As raparigas verá-no no cinema.*
Final nasal sounds are *not* omitted! This type of contraction occurs only when the final letter of the verb form is 'r', 's' or 'z'.
You later rewrote sentence 9 correctly.

7. O Manuel e o seu filho dir-lho-iam mais tarde.
You wrote: *O Manuel e o seu filho dí-lho-iam mais tarde.*
Phonetic contractions only occur with the direct object pronoun (o/a/os/as), however with the combined form (eg. lho), no such phonetic contraction is required. Your error may be may be a result of confusion about direct/indirect/combined object pronouns, the false assumption that phonetic contractions occur with all types of pronoun or only with combined object pronouns, or the 'l' of lho may have prompted you to make the contraction.

16. Tem-lo visto.
You wrote: *Tens-o visto.*
It is very easy to make a mistake with this sentence! Tens + o becomes tem-lo. (The final 's' must be omitted, and because in Portuguese words may not end in 'n', this new final 'n' must change to 'm'. O becomes lo.)

20. As raparigas vê-lo-ão no cinema.
You wrote: *As raparigas vé-lo-ão no cinema.*
You have used the wrong type of accent.

<u>Positioning in different types of sentence</u>

There were 12 different sentence types represented in the test, accounting for 24 of the 25 questions. These are as presented in the list of pronoun placement rules provided for the second part of the test. Your score for pronoun placement (ignoring any problems of phonetic contractions) for each of these sentence types is presented below. (The maximum for each is 2.) The first score relates to the first part of the test, and a second score is provided if there is any change after viewing the rules.

negative clauses:	2	
open questions:	2	
affirmative main clauses:	2	
positive imperatives:	2	
infinitives:	2	
certain adverbial phrases:	2	
yes/no questions:	1	
future tense:	0*	(1)*
conditional tense:	0	(2)
subordinate clauses:	2	
relative clauses:	2	
auxiliary and past participle:	1	(2)

* Your maximum possible here was 1, because you answered one of the 'future' questions differently from how I had intended. Nevertheless your answer was correct, but relates to infinitives and not to the future.

S9

We hope the test and this feedback has been useful for you. It would be very helpful to us if you could find time to answer (all or just some of) the following questions about your test, though of course, you are under no obligation to do so. You may answer anonymously if you prefer. (Even answers such as 'don't know' are useful.) If you are able to help, please return the questionnaire in the envelope provided. Thank you.

****

Question 7

Did you believe that the pronoun comes after the verb in conditional sentences?
*Yes, * where it was usual to place pronouns after, e.g. present tense.*
Did you realise that this was the conditional tense? *Yes.*
If not, what tense did you think it was?
Did you assume the rule used in positive main clause statements was applicable?
Yes.
Any other comments? *I had completely forgotten conditional/future tenses infix their pronouns.*

Question 16

Can you explain why you placed the pronoun after the past participle?
I didn't know it was supposed to be attached to the auxiliary.
Any other comments? *Even if I had, I didn't know "Tens-o" was correctly written "Tem-lo".*

Question 20

Did you believe that the pronoun comes after the verb in future sentences?
*Yes, * see question 7 response.*
Did you realise that this was the future tense? *Yes.*
If not, what tense did you think it was?
Did you assume the rule used in positive main clause statements was applicable?
Yes.
Any other comments? *See question 7.*

Question 23

Did you believe that the pronoun comes before the verb in conditional sentences?
See question 7.
Did you realise that this was the conditional tense?
Any other comments?

****

Questions 1/7/9/20

Why did you omit the final nasal sounds? *I was confused between omitting final "s", "r" or "z" and nasal sounds. I thought they were all omitted.*

Question 7

Why did you make the contraction 'l' before 'lho'? *Because of omission of "r" before pronoun rule. I was unaware this only applied to direct objects.*

Question 16

Why did you not make any phonetic changes? *I didn't know I had to change tens to tem (and I thought I may as well omit what I didn't know!!) NB I knew "ten-no" was wrong, but didn't know to use "m".*

Question 20

Why did you use the wrong accent on 'é'? *Don't know, accidental.*

****

Did you compare the Portuguese rules to any other languages?

Not for pronouns.

If so, which languages?

Was thinking about the above questions useful or interesting to you in any way?

Yes - revision! Especially as I could test what I knew i.e. I couldn't use my notes.

Portuguese Pronoun Test

S15

Your original score for pronoun placement was 21/25. After consulting the list of pronoun placement rules, you scored 21/25.

Your difficulties of word order with pronouns were with the following sentences:

3. O Manuel e o seu filho dir-lho-iam mais tarde.
You wrote: *O Manuel e o seu filho diriam-lho mais tarde.*
You have placed the pronoun after the verb. This is incorrect, because although in an affirmative main clause statement the pronoun is usually post-verbal, in this case the conditional tense has been used which means that a pronoun which would normally occur post-verbally becomes an infix (see rule 11). Your error could be a result of overgeneralisation of rule 1, or you may not have realized that 'diriam' is a conditional form.

16. Assim o faz todos os dias.
You wrote: *Assim fá-lo todos os dias.*
'Assim' is one of those adverbs after which the pronoun must be pre-verbal (see rule 9). Your error could be a result of applying rule 1 (correct for most affirmative main clause statements), instead of 9.

22. As raparigas vê-lo-ão no cinema.
You wrote: *As raparigas verão-no no cinema.*
You have placed the pronoun after the verb. This is incorrect, because although in an affirmative main clause statement the pronoun is usually post-verbal, in this case the future tense has been used which means that a pronoun which would normally occur post-verbally becomes an infix (see rule 10). Your error could be a result of overgeneralisation of rule 1, or you may not have realized that 'verão' is a future form.

25. A mulher decidir-se-á por ir.
You wrote: *A mulher se decidirá por ir.*
You have placed the pronoun in pre-verbal position. This is incorrect, because in an affirmative main clause statement the pronoun should usually be post-verbal. However, in this case the future tense is used, which means that a pronoun which would normally occur post-verbally becomes an infix (see rules 1/10).

Your problems with phonetic contractions were with the following sentences:

12. Tem-lo visto.
You wrote: *Tem-no visto.*
This is a very easy mistake to make! You have remembered to alter the 'ns' to 'm' (as the final 's' must be omitted, and because in Portuguese words may not end in 'n', this new final 'n' must change to 'm'). However, tens + o actually becomes tem-lo. Your mistake is probably due to the fact that in other cases where verb forms end in a nasal sound, the third person direct object is prefixed by 'n'.

Positioning in different types of sentence

There were 12 different sentence types represented in the test, accounting for 24 of the 25 questions. These are as presented in the list of pronoun placement rules provided for the second part of the test. Your score for pronoun placement (ignoring any problems of phonetic contractions) for each of these sentence types is presented below. (The maximum for each is 2.)

negative clauses:	2
open questions:	2
affirmative main clauses:	2
positive imperatives:	2
infinitives:	2
certain adverbial phrases:	1
yes/no questions:	2
future tense:	0
conditional tense:	1
subordinate clauses:	2
relative clauses:	2
auxiliary and past participle:	2

S15

We hope the test and this feedback has been useful for you. It would be very helpful to us if you could find time to answer (all or just some of) the following questions about your test, though of course, you are under no obligation to do so. You may answer anonymously if you prefer. (Even answers such as 'don't know' are useful.) If you are able to help, please return the questionnaire in the envelope provided. Thank you.

****

Question 3

Did you believe that the pronoun comes after the verb in conditional sentences?
No.
Did you realise that this was the conditional tense? *No.*
If not, what tense did you think it was?
Any other comments? *I was so interested in making the correct formation of the + o -> lho, that I forgot then all about the conditional tense.*

Question 16

Did you realise that some adverbs cause the pronoun to be pre-verbal? *Yes.*
Did you assume this was a normal positive main clause statement, and for this reason place the pronoun after the verb? *Yes.*
Any other comments? *Didn't realise "assim" was one of those adverbs. It's less common.*

Question 22

Did you believe that the pronoun comes after the verb in future sentences? *No.*
Did you realise that this was the future tense? *No.*
If not, what tense did you think it was? *Probably present!*
Did you assume the rule used in positive main clause statements was applicable?
Yes. I thought it was just a "normal, easy" one.
Any other comments?

Question 25

Did you believe that the pronoun comes before the verb in future sentences? *No.*
Did you realise that this was the future tense? *Yes.*
If not, what tense did you think it was?
Any other comments? *But I got confused because it was "se". Plus, in Brazil "se" is always put in the opposite place than it is in Portuguese. "Se" always gives me problems.*

****

Question 12

Why did you write 'no' instead of 'lo'? *I thought the "Tem" was nasal so it should be followed by "no". It's only now that I realise the "lo" comes from the -s in tens..... Very interesting!!*

****

Did you compare the Portuguese rules to any other languages? *No.*
If so, which languages?

Was thinking about the above questions useful or interesting to you in any way?
It was good to compare all the different ways in which pronouns and contractions are used. It made me realise just how careful you have to be when writing ANYTHING. Also, it's interesting how you may have to apply one or two rules to one sentence.
Really helpful. Thanks.

Portuguese Pronoun Test

S45

Your original score for pronoun placement was 17/25. After consulting the list of pronoun placement rules, you scored 21/25.

<u>Your difficulties of word order with pronouns were with the following sentences:</u>

1. A Ana deu-lhe o livro?
You wrote: *A Ana lhe deu o livro?*
This is a yes/no question (i.e. requires the answer 'yes' or 'no'). In this type of question the pronoun occurs in post-verbal position (see rule 4). (For open questions, the reverse is true.) Your error may have been due to the fact that you were confusing the two types of question, or simply that you believed that in positive (yes/no) questions, the pronoun should occur before the verb.

5. O Manuel e o seu filho dir-lho-iam mais tarde.
You wrote: *O Manuel e o seu filho diriam-lho mais tarde.*
You have placed the pronoun after the verb. This is incorrect, because although in an affirmative main clause statement the pronoun is usually post-verbal, in this case the conditional tense has been used which means that a pronoun which would normally occur post-verbally becomes an infix (see rule 11). Your error could be a result of overgeneralisation of rule 1, or you may not have realized that 'diriam' is a conditional form.

6. Tem-lo visto.
You wrote: *Tens visto o.*
You have placed the pronoun after the past participle. This is incorrect, because the pronoun should be attached after the auxiliary.
After seeing the list of rules you rewrote this sentence placing the pronoun in the correct position (though you did not make the necessary phonetic contraction).

10. As raparigas vê-lo-ão no cinema.
You wrote: *As raparigas o verão no cinema.*
You have placed the pronoun in pre-verbal position. This is incorrect, because in an affirmative main clause statement the pronoun should usually be post-verbal. However, in this case the future tense is used, which means that a pronoun which would normally occur post-verbally becomes an infix (see rules 1/10).

11. O rapaz tem-na aberto.
You wrote: *Ao rapaz tem aberto.*
The pronoun should be between the auxiliary and past participle, attached after the auxiliary.

13. No teu caso, comprá-lo-ia.
You wrote: *No teu caso, o compraria.*
You have placed the pronoun in pre-verbal position. This is incorrect, because in an affirmative main clause statement the pronoun should usually be post-verbal. However, in this case the conditional tense is used, which means that a pronoun which would normally occur post-verbally becomes an infix (see rules 1/11).
After seeing the list of rules you rewrote this sentence placing the pronoun in the correct position (though there was still a problem with the phonetic contraction).

14. Queres comê-lo?
You wrote: *O queres comer?*
This is a yes/no question (i.e. requires the answer 'yes' or 'no'). In this type of question the pronoun occurs in post-verbal position (see rule 4). (For open questions, the reverse is true.) Your error may have been due to the fact that you were confusing the two types of question, or simply that you believed that in positive (yes/no) questions, the pronoun should occur before the verb. Furthermore, with infinitives the pronoun is post-verbal. You have, in fact, associated the pronoun with the wrong verb.
After seeing the list of rules you rewrote this sentence placing the pronoun in the correct position (though you did not make the necessary phonetic contractions).

18. O professor viu que o lias.
You wrote: *O professor viu que lias o.*
The pronoun is pre-verbal in subordinate clauses. Your error may have occurred because you were overgeneralising the rule applicable in main clause statements (rule 1). Alternatively you may have held the specific misconception that the pronoun is post-verbal in subordinate clauses.
After seeing the list of rules you rewrote this sentence correctly.

<u>Your problems with phonetic contractions were with the following sentences:</u>

2. Dão-no ao teu amigo.
You wrote: *Dão-o ao teu amigo.*
7. Os fabricantes vendem-nos nesta loja.
You wrote: *Os fabricantes vendem-os nesta loja.*
When a verb form ends in a nasal sound, and the verb is followed by a third person direct object pronoun - this pronoun is prefixed by 'n'.

15. Abre-a agora!
You wrote: *Abre-laagora!*
17. Vende-as!
You wrote: *Vende-las!*
You only need to prefix 'l' to the pronoun in cases where the final letter of the appropriate verb form is 'r', 's' or 'z' (in which case this final letter would be omitted, and an additional accent may be required).

23. Já lhe disse a verdade.
You wrote: *Já lhe-disse a verdade.*
You have attached a *pre-verbal* pronoun to the verb with a hyphen. Hyphens are only used when the pronoun *follows* the verb.

24. O António vai trazê-la agora.
You wrote: *O António vai trazer a agora.*
13. No teu caso, comprá-lo-ia.
You wrote: *No teu caso, comprá-o-ia.*
14. Queres comê-lo?.
You wrote: *Queres comeros?*
When the final letter of a verb form is 'r', 's' or 'z', and the verb is followed by a third person direct object pronoun - this final letter is omitted. An accent is often required on the new final vowel, and the pronoun is prefixed by 'l'. Note also that you have attached the pronoun directly to the verb in sentence 14, instead of using a hyphen!

21. Amanhã queremos escrever-lhe.
You wrote: *Amanhã queremos escrevé-lhe.*
It would be correct to make a phonetic contraction with the direct object pronoun (o/a), however with the indirect object pronoun (lhe), no such phonetic contraction is required. Your error may be may be a result of confusion about direct/indirect object pronouns, the false assumption that phonetic contractions occur with both types of pronoun or only with indirect object pronouns, or the 'l' of lhe may have prompted you to make the contraction. Note that if such a contraction were required, the accent needed would be ^ and not ´. Interestingly, your first attempt at this sentence was correct!

<u>Positioning in different types of sentence</u>

There were 12 different sentence types represented in the test, accounting for 24 of the 25 questions. These are as presented in the list of pronoun placement rules provided for the second part of the test. Your score for pronoun placement (ignoring any problems of phonetic contractions) for each of these sentence types is presented below. (The maximum for each is 2.) The first score relates to the first part of the test, and a second score is provided if there is any change after viewing the rules.

negative clauses:	2	
open questions:	2	
affirmative main clauses:	2	
positive imperatives:	2	
infinitives:	2	
certain adverbial phrases:	2	
yes/no questions:	0	(1)
future tense:	0*	
conditional tense:	0	(1)
subordinate clauses:	1	(2)
relative clauses:	2	
auxiliary and past participle:	0	(1)

* Your maximum possible here was 1, because you answered one of the 'future' questions differently from how I had intended. Nevertheless your answer was correct, but relates to infinitives and not to the future.

S45

We hope the test and this feedback has been useful for you. It would be very helpful to us if you could find time to answer (all or just some of) the following questions about your test, though of course, you are under no obligation to do so. You may answer anonymously if you prefer. (Even answers such as 'don't know' are useful.) If you are able to help, please return the questionnaire in the envelope provided. Thank you.

****

Question 1

Were you confusing yes/no and open questions? *Yes.*

Did you believe that in positive *yes/no* questions, the pronoun should come before the verb? *Yes.*

Did you believe that in *all* positive questions, the pronoun should come before the verb? *Yes.*

Any other comments?

Question 5

Did you believe that the pronoun comes after the verb in conditional sentences? *Didn't know.*

Did you realise that this was the conditional tense? *No.*

If not, what tense did you think it was? *Imperfect.*

Did you assume the rule used in positive main clause statements was applicable? *Yes.*

Any other comments?

Question 6

Can you explain why you placed the pronoun after the past participle? *Either I thought it had to go after PP, or Tens o visto just didn't sound right.*

Any other comments?

Question 10

Did you believe that the pronoun comes before the verb in future sentences? *No.*

Did you realise that this was the future tense? *No.*

If not, what tense did you think it was?

Any other comments? *Didn't understand sentence. Thought verao meant summer and couldn't really mix o with ao.*

Question 11

Can you explain why you did not place the pronoun with a verb?

Tem o aberto didn't sound right.

Question 13

Did you believe that the pronoun comes before the verb in conditional sentences.

No.

Did you realise that this was the conditional tense? *No.*

If not, what tense did you think it was? *Imperfect.*

Any other comments? *Just thought it had to come before, being negative question, and as I thought it was an imperfect.*

Question 14

Were you confusing yes/no and open questions? *Yes.*

Did you believe that in positive *yes/no* questions, the pronoun should come before the verb? *I thought it was the case with all questions.*

Did you believe that in *all* positive questions, the pronoun should come before the verb? *Yes.*

Do you know why you associated the pronoun with the wrong verb?

Because it was a question.

Any other comments?

Question 18

Did you believe that the pronoun comes after the verb in subordinate clauses?

Yes.

Did you assume the rule used in positive main clause statements was applicable?

Didn't know.

Any other comments?

****

Questions 2/7

Why did you write 'o' instead of 'no', and 'os' instead of 'nos'?

Didn't know others existed.

Questions 15/17

Why did you write 'la' instead of 'a', and 'las' instead of 'as'?

They sounded better.

Question 23

Why did you attach a pre-verbal pronoun to the verb using a hyphen?
I thought all indirect pronouns had hyphens.

Questions 24/13/14

Why did you have problems with the phonetic contractions?
Didn't know they existed.
Why did you make *different* mistakes with each answer?
24 & 14 aren't too different.

Question 21

Why did you make the contraction 'é' before 'lhe'?
Don't know.

****

Did you compare the Portuguese rules to any other languages?
Sounds & most things.
If so, which languages?
Spanish & French a bit.

Was thinking about the above questions useful or interesting to you in any way?
Yes it helped me understand where I went wrong, thank you.

Appendix C

Error types observed

Sentence structure

wrong attachment: pronoun associated with wrong verb

Quero vê-los --> * Querena-lhes ver (I want to see them)

The pronoun is attached to the wrong verb: *querer* instead of *ver*.
(Note that the tense is also incorrect, and the IO pronoun has been used instead of the DO pronoun.)

wrong attachment: pronoun associated with non-verb

Dá-lhe o dinheiro --> * Dá o dinheiro-lhe (He gives him the money)

The pronoun is attached to a non-verb - here the noun *dinheiro*.

both pronoun and object noun in sentence

Não lhas dá --> * Não lhas dá á irmão (He does not give them to her)

The combined form of the pronoun (*lhas*) indicates 'them to her'. Although the object of the sentence is included in this pronoun, the student has also provided the object: *irmã* (sister).
(Note also the incorrect accent 'á', and final 'o' on *irmã* (*irmão* = brother).)

both pronoun and possessive (no noun) in sentence

Oferece-lho --> * Oferece o seu lho (He offers it to him)

O seu means 'his'. Thus the possessive appears in the student's sentence despite the occurance of the pronoun. (The student's sentence translates as 'He offers his it to him'.) This error was probably prompted by the type of exercise in which it appeared, but this nevertheless indicates a lack of understanding of the role of pronouns (or possessives).

object pronoun as subject

Não lhas vende --> * Lho não vende as males lhes (He does not sell them to him)

Lho appears to have been used as a subject pronoun, even though it is the combined form of direct and indirect object (*lhe* + *as*: 'them to him'). The indirect object *lhes* is probably the one intended to reflect the object of the sentence.
(Note the misspelling of *malas* (suitcases).)

preposition and indirect object

Oferece-lhe o seu passaporte --> * Oferece o seu passaporte ao lhe (He offers him his passport)

Ao ('to the') appears as well as the indirect object *lhe* ('to him').

missing pronoun: indirect object

Dá-lhe o dinheiro --> * Dá o dinheiro (He gives him the money)

The IO pronoun has been omitted.

missing pronoun: direct object

Pô-la-ás na mesa? --> * Na porás? (Will you put it on the table?)

The DO pronoun is missing. It is possible that the learner was confusing *na* with the pronoun, however *na* means 'on the'.

missing pronoun: reflexive

Levantámo-nos --> * Levantámos (We got up)

Levantar-se is reflexive. The reflexive pronoun has been omitted.

IO & DO pronouns

IO/DO object pronouns: within type: combined form

Não lha escreve --> * Não lhas escreve (She does not write it to them)

The incorrect combined form has been used. The target was *lhes + a*, which joins to form *lha*. (*Lhas* occurs with *lhe* or *lhes + as* - i.e. 'them', rather than 'it'.)

IO/DO object pronouns: within type: single form: IO

Não lhes escreve --> * Não escreve-lhe (She does not write to them)

The singular form of the indirect object pronoun has been used in place of the plural. (Note also the wrong position of the pronoun.)

IO/DO object pronouns: within type: single form: DO

Abri-la-emos --> * Abri-lo-emos (We will open it)

The masculine form of the direct object pronoun has been used in place of the feminine.

IO/DO object pronouns: within type: reflexive

Levantámo-nos --> * Se levantamós (We got up)

The third person reflexive pronoun has been used in place of the first person plural.
(Note also the wrong position of the pronoun, and accent on the wrong vowel.)

IO/DO object pronouns: across type: with combined forms: combined for disjunctive

Apresenta-me a ti --> * Apresenta-me-to (She introduces me to you)

The student has used the combined form *to* (*te* + *o*) in place of the disjunctive.

IO/DO object pronouns: across type: with combined forms: combined for IO

Não lhe dá as fotografias --> * Não lha dá as fotografias (He does not give the photographs to him)

The combined form of the pronoun has been used in place of the indirect object pronoun.

IO/DO object pronouns: across type: with combined forms: combined for DO

Têm-no --> * Têm-lho (They have it)

The combined form of the pronoun has been used in place of the direct object pronoun.

IO/DO object pronouns: across type: with combined forms: IO for combined

Quem lho oferecerá? --> * Quem lhe oferecerá? (Who will offer it to her?)

The indirect object pronoun *lhe* has been used in place of the combined form *lho* (*lhe* + *o*).

IO/DO object pronouns: across type: with combined forms: DO for combined

Quem lho oferecerá? --> * Quem o oferecerá? (Who will offer it to her?)

The direct object pronoun *o* has been used in place of the combined form *lho* (*lhe* + *o*).

IO/DO object pronouns: across type: IO for DO

Quero vê-los --> * Quero de ver-lhes (I want to see them)

The indirect object pronoun has been used in place of the direct object pronoun.
(Note also the use of *de*.)

IO/DO object pronouns: across type: (DO for IO)

In the data collected there were no actual examples of direct object used in place of indirect object pronoun. However this error type has been included here because it may occur in a larger sample.

IO/DO object pronouns: disjunctives: no disjunctive form

Apresenta-me a ti --> * Apresenta-me a te (She introduces me to you)

The object pronoun *te* has been used in place of the disjunctive *ti*.

IO/DO object pronouns: disjunctives: disjunctive inappropriately used

Dou-to --> * Dou o á ti (I give it to you)

Here a combined form is required - *o* ('it') + *te* ('to you') --> *to*. The student who produced this error was probably overgeneralising the recently learnt disjunctives to the previously encountered situations where combined forms are required.
(Note also that this student has not used a hyphen to attach the first pronoun to the verb, and *á* has been given an accent, which would not occur if the disjunctive were the appropriate form.)

IO/DO object pronouns: disjunctives: combine 1st/2nd person DO

Apresenta-me a ti --> * Apresenta-me to (She introduces me to you)

The disjunctive form *ti* should have been used, as there is a co-occurrance of non-3rd person DO with IO. However, the student has not used the disjunctive, and further, she has used a combined pronoun (*te* + *o* --> *to*), despite the fact that the DO *me* is also provided.

Phonetic contractions

phonetic contractions: reflexives: s remaining

Levantámo-nos --> * Levantamos-nos (We got up)

The final *s* of the third person plural form of the verb before the reflexive *nos* has not been omitted. (Note also the missing accent from the verb.)

phonetic contractions: reflexives: os removed

Levantámo-nos --> * Levantám-nos (We got up)

Instead of removing only the final *s*, the student has also removed the *o*. This may have been due to confusion with non-reflexive *n + os* (see 2 above).

phonetic contractions: reflexives: s removed

Abri-la-emos --> * Abrir-la-emo (We will open it)

The final *s* has been omitted. The student may have overgeneralised the removal of the *s* in the 3rd person plural of reflexive verbs before *nos*, to removal of the *s* from any 3rd person plural verb form occuring with a pronoun[3].
(Note that the final *r* has not been removed from the infinitive stem.)

phonetic contractions: nasals/r/s/z: l inappropriate

Dou-to --> * Dou-lo a ti (I give it to you)

The student has here added l to the pronoun o, even though this is inappropriate (as the final letter of the preceding verb is not *r*, *s* or z).
(Note also that the student has used the disjunctive in place of the combined form of the pronoun.)

phonetic contractions: nasals/r/s/z: l missing

Traduzi-las-ão --> * Traduzê-as-ão (They will translate them)

The student has not affixed the *l* to the pronoun.
(Note also that the verb form has been declined as an 'er' verb, rather than 'ir'.

---

3 The learner may instead have been confused by the rule stating that the final *s* of verb forms should be deleted be deleted before 3rd person direct object pronouns. The true cause of this error has not been verified.

phonetic contractions: nasals/r/s/z: n missing

Têm-no --> * Têm o (They have it)

The student has not affixed the *n* to the pronoun.
(Note also the omission of the hyphen.)

phonetic contractions: nasals/r/s/z: r remaining

Quero vê-los --> * Quero ver-los (I want to see them)

The student has not omitted the final *r* on *ver* (or added the accent).

phonetic contractions: nasals/r/s/z: z remaining

Fá-lo --> * Faz o (She does it)

The student has not omitted the final *z* on *faz*.
(Note also that the *l* has not been added to the pronoun, nor has the accent been added.)

phonetic contractions: nasals/r/s/z: accent missing

Quero vê-los --> * Quero ve-los (I want to see them)

The student has not remembered to add the accent to *e*, after removing the verb-final *r*.

Phonetic contractions: nasals/r/s/z: wrong accent

Bebê-lo-ão --> * Bebé-lo-ão (They will drink it)

The student has remembered the accent, but has used ´ instead of ^.

phonetic contractions: nasals/r/s/z: accent inappropriately provided

Abri-la-emos --> * Abrí-la-emos (We will open it)

The student has provided an accent where none is required.

phonetic contractions: nasals/r/s/z: lo for no

Dão-no ao professor --> * Dão-lo ao professor (They give it to the teacher)

The learner has here realised that there must be some modification to the pronoun after a verb form ending in a nasal sound, but has affixed *l* to the pronoun as would occur after a verb form ending in *r*, *s* or *z*, instead of the correct *n*, as applies after a nasal ending.

phonetic contractions: nasals/r/s/z: no for lo

Comê-los-ão --> * Comê-nos-ão (They will eat them)

Instead of affixing *l* to the front of the pronoun after deletion of the final *r* of the infinitive stem, the student has affixed *n*, as would occur after a nasal sound.

phonetic contractions: nasals/r/s/z: deleted final letter

Puseram-no na mesa --> * Pusera-no na mesa (They put it on the table)

The learner has omitted the final *m* of *puseram* - probably as an overgeneralisation of the rule which states that a final *r*, *s* or *z* must be deleted before a 3rd person direct object pronoun.

phonetic contractions: nasals/r/s/z: future/conditional - infix problems

Apagá-la-á --> * Apagá-la-rá (She will switch it off)
* Apagárá-la-á

Unlike with the other tenses, in the future and conditional the object pronoun becomes an infix between the infinitive stem and verb ending (see section ???). In the first of the above examples the student has transposed the infinitive *r* onto the verb ending after the pronoun, instead of deleting the *r*. In the second example the student has used the full form of the future (infinitive stem and future ending), then positioned the pronoun, and then again added the future verb ending.

Hyphens

pronoun joined to verb (i.e. no hyphen)

Quero comprá-las --> * Quero compralas (I want to buy them)

The pronoun has been joined directly onto the end of the verb (i.e. no hyphen has been used). (Note also the lack of accent, despite correct addition of *l*.)

hyphen missing

Oferece-lhe o seu passaporte --> * Oferece lhe o seu passaporte (He offers him his passport)

The hyphen has been omitted.

pronoun-hyphen-verb

Não se sente! --> * Não se-sente! (Don't sit down!)

A pre-verbal pronoun has been attached to the verb with a hyphen.

negative-hyphen

Não lhas vende --> * Não-lhas vende (He does not sell them to him)

The pronoun has been attached to the negative.

Appendix D

Individuals' errors

Individuals' errors from the categories identified in figure 4.1.1 (study 1)

Key:

30 X 19 = 30 errors made by 19 different students.
no-lo -> mas = mas was used where no-lo was required.
lha -> lho (X2) = 2 occurrances of this error.
-acc/+l = accent was omitted, but l was provided.

In a few cases only a number is given, e.g. for *reflexives: s remaining*. This is because there is only one error possible: non-omission of verb-final *s* before reflexive *nos*.

+ indicates a large number of the corresponding error.
(*) asterisks indicate the number of times this error was made in the final exercise. (One asterisk per error.)

Errors:	*within: comb 30 X 19*	*within: IO 1 X 1*	*within: DO 5 X 5*	*within: refl 1 X 1*
S1	no-lo -> mas			
S2	lha -> lho (X2) lhas -> lha tem de dizer-no-lo -> nos diz lhe		la -> o	
S3				
S4				
S5				
S6				
S7				
S8				
S9				
S10				
S11				
S12				
S13				
S14	lha -> lhas mas -> mos			
S15				
S16	lha -> lhas			
S17				
S18	lha -> lhas			
S19				
S20				
S21				
S22	no-lo -> no mas -> mos	lhes -> lhe		
S23	lha -> lhos			
S24	lha -> lhos lha -> lho lhas -> lho			

S25				
S26	no-lo -> no-los			nos -> se
S27	mas -> mos			
S28	lhas -> lhos			
S29				
S30	lha -> lhas		la -> lo	
S31				
S32				
S33				
S34	lha -> lhas			
S35	lha -> lho			
S36				
S37				
S38	lha -> lhos			
S39	to -> te-lo mas -> me-lhas			
S40				
S41	to -> te ..... o no-lo -> nos-o mas -> me las			
S42				
S43			no -> na	
S44				
S45			lo -> la	
S46	mas -> mos			
S47	to -> te .. .. o		no -> na	

Errors:	*across: comb/disj 2 X 2*	*across: comb/IO 10 X 8*	*across: comb/DO 8 X 5*	*across: IO/comb 3 X 2*
S1				
S2			no -> lho la -> lho	lho -> lhe lhas -> lhes
S3				
S4				
S5		lhe -> lha		
S6				
S7			as -> lhas	
S8				
S9				
S10				
S11				
S12				
S13				
S14	a tu -> to	lhe -> lha lhes -> lhas	la -> lha lo -> lho no -> lho	
S15				lho -> lhe
S16				
S17				
S18		lhe -> lha		
S19				
S20				
S21				
S22		lhe -> lha		
S23				
S24				
S25			los/las -> lhas	
S26				
S27		lhe -> lha		

S28			las -> lhas	
S29				
S30				
S31				
S32				
S33				
S34				
S35		lhes -> lhos lhe -> lho		
S36		lhe -> lha		
S37				
S38				
S39				
S40				
S41		lhe -> lha		
S42	a ti -> ta			
S43				
S44				
S45				
S46				
S47				

Errors:	*across: DO/comb 3 X 3*	*across: IO/DO 27 X 12*	*disj: no disj 13 X 13*	*disj: unappropriate 5 X 3*
S1		no -> lhe los -> lhes		
S2		os -> lhes lo -> lhe (X3) los -> lhes (X3) la -> lhe (X2) las -> lhes	a ti -> a tu	
S3		los -> lhes	a ti -> a te	
S4			a ti -> a te	
S5		los -> lhes		
S6				
S7				
S8				
S9		los -> lhes		
S10				to -> lo a ti
S11				
S12				
S13		los -> lhes		
S14		los -> lhes		lho -> o seu a ele
S15	lhas -> as			
S16	lho -> lo		a ti -> a tu	
S17				
S18		los -> lhes	a ti -> a te	
S19				
S20		los -> lhes	a ti -> a tu	
S21				
S22			a ti -> a tu	
S23				
S24		los -> lhes		
S25				
S26			a ti -> a tu	
S27			a ti -> a te	
S28		os/lo/la/los -> lhes/lhe (X9) no -> lhe	a ti -> a tu	

S29	lho -> o			
S30				
S31			a ti -> a tu	
S32				
S33				
S34				
S35				to -> o á ti no-los -> o á nos mas -> as á me
S36				
S37				
S38			a ti -> a te	
S39			a ti -> a tu	
S40				
S41				
S42				
S43				
S44				
S45		los -> lhes		
S46				
S47				

Errors:	*comb 1st/2nd DO 2 X 2*	*refl: s remaining 15 X 13*	*refl: os removed 2 X 2*	*refl: s removed 1 X 1*
S1		2		
S2		1		
S3				
S4		1		
S5		1		
S6		1		
S7				
S8				
S9				
S10				
S11				
S12				
S13		1		
S14	a ti -> to			
S15				
S16		1		
S17				
S18				
S19				
S20				
S21				
S22				nos (refl. pro.) -> no
S23		1		
S24				
S25		1		
S26				
S27				
S28		2		
S29				
S30				
S31				
S32				
S33				

S34		l		
S35				
S36				
S37				
S38		l		
S39			l	
S40				
S41				
S42	a ti -> ta			
S43				
S44			l	
S45				
S46		l		
S47				

Errors:	*refl: accent 1 X 1*	*n/r/s/z: l unapprop 3 X 3*	*n/r/s/z: l missing 4 X 4*	*n/r/s/z: n missing 4 X 4*
S1				
S2		o -> lo		no -> o
S3				
S4				
S5			la -> a (+r)	no -> o
S6				no -> o
S7				
S8			las -> as	
S9			las -> as	
S10				
S11				
S12				
S13	nos -> nós			
S14				
S15				
S16				
S17				
S18			as -> las (+r/-acc)	
S19				
S20				no -> o
S21				
S22				
S23				
S24				
S25				nos -> os
S26				
S27				
S28				
S29				
S30				
S31				
S32				
S33				
S34				
S35				
S36				
S37				
S38				no -> o
S39				
S40				
S41		as -> las		

S42				
S43				
S44				
S45				no -> o
S46		a -> la		
S47				

Errors:	*n/r/s/z: r remain 46 X 19*	*n/r/s/z: s remain 5 X 3*	*n/r/s/z: z remain 4 X 4*	*n/r/s/z: acc miss 22 X 12*
S1	l -acc (X3) -l/+n -acc/DO -> IO -acc/-l/+n (X2)			
S2	-acc/DO -> comb -acc/DO -> IO	DO -> IO		
S3	-acc/DO -> IO			á
S4				
S5	-l -acc/DO -> IO			
S6				
S7	-acc/+l (X3) -acc/DO -> comb	+l DO -> comb		á ê
S8	4			
S9				ô
S10				
S11				
S12				á
S13	-acc/DO -> IO			
S14	-acc/DO -> comb -acc/+l -acc/-l (X3)		-acc/DO -> comb	
S15				á ô
S16				
S17	+l/+acc (X3)			
S18	-acc/-l -acc/-l/+n (X3)			ê
S19				
S20			-acc/-l	á (X2) ê (X2)
S21				
S22				
S23				
S24	-acc/DO -> IO			
S25	-acc/DO -> comb	-l -acc/-l	-acc/+l	
S26	-acc/DO -> comb			á ô
S27				
S28	-acc/+l		-acc/DO -> IO	
S29				ê (X2) ô
S30				
S31				
S32				
S33				
S34				
S35	-acc/+l -acc/-l			á
S36				
S37				
S38				

S39	-acc/DO -> IO			
S40				
S41	-acc/+1 (X2)			á
S42				
S43	-acc/+1 (X2)			
S44				
S45	-acc/DO -> IO			á (X2)
S46				
S47				

Errors:	*n/r/s/z: wrong acc 6 X 5*	*n/r/s/z: acc inappr 17 X 13*	*n/r/s/z: lo/no 3 X 1*	*n/r/s/z: no/lo 7 X 3*
S1		á		3
S2			3	
S3		á		
S4				
S5				
S6				
S7				
S8		á ô		
S9				
S10				
S11				
S12				
S13		á		1
S14				
S15		á í (X3)		
S16		á		
S17				
S18				3
S19				
S20				
S21				
S22		ô		
S23				
S24				
S25				
S26	é	á		
S27		í		
S28		í		
S29		á		
S30				
S31				
S32				
S33				
S34				
S35	é	í		
S36				
837				
S38				
S39				
S40				
S41	é			
S42				
S43				
S44	á			
S45		á		
S46	é (X2)			

S47				

Errors:	*n/r/s/z: del final 4 X 3*	*n/r/s/z: infix 2 X 2*	*hyphen: joined 13 X 4*	*hyphen: missing lots X 41*
S1	s			2
S2				+ (*)
S3				6
S4	s			+
S5	m (X2) r		1	+ (*)
S6		apagá-la-á -> apagá-la-rá		+
S7				+
S8				+
S9				
S10				+
S11				+
S12				
S13				+
S14				+
S15				+
S16				+
S17		apagá-la-á -> apagárá-la-á		+
S18				+
S19				
S20			2	2 (**)
S21				1
S22				+
S23				
S24				+
S25				6 (******)
S26			9	+
S27				+
S28				+
S29				+ (*)
S30				+
S31				+
S32				+
S33				
S34				+
S35				+
S36				+
S37				+
S38				+
S39				+
S40				+
S41			1	+
S42				+ (*)
S43				+
S44				+
S45				+
S46				
S47				3

Errors:	*hyphen: pro-hy-v 12 X 6*	*hyphen: neg-hy 11 X 4*		
S1	1			
S2				
S3				
S4	1	1		
S5				
S6				
S7				
S8	1			
S9				
S10				
S11				
S12				
S13				
S14				
S15	1	2		
S16				
S17				
S18				
S19				
S20				
S21				
S22				
S23	6			
S24				
S25				
S26				
S27				
S28				
S29				
S30				
S31				
S32				
S33				
S34				
S35				
S36				
S37				
S38				
S39				
S40		4±		
S41				
S42				
S43				
S44				
S45	2	4±		
S46				
S47				

± The exercise in which these errors occured had identical errors for S40 and S45, suggesting that they may have worked together, or one may have copied the work of the other.

Appendix E

General information about learning strategies in Mr. Collins

The descriptions in (1) below show information obtainable by students about learning strategies, together with explanations of how these strategies can be used in the system. As this is general information for consultation, these explanations are simple canned text. They are based on the language learning strategy descriptions of O'Malley and Chamot (1990). Information about each strategy selected for consideration appears in a separate window.

1. Strategies traced by the system:

METACOGNITIVE STRATEGIES:

Strategy planning involves thinking about appropriate learning strategies to cope with the language task.
You can help plan your strategy use by finding out more information about strategies, as you are doing now.
You may also ask the system what strategies might be useful for you through selecting "learning strategies" from the STUDENT MENU.
You may inform the system about your use (or lack of use) of this strategy by selecting "learning strategies" from the STUDENT MENU, and then choosing "Your Use of Strategies".

Self-monitoring involves checking, verifying or correcting your own performance during the task.
The issues relevant in this system are checking production, which may be in the form of visual monitoring (i.e. whether a sentence looks right), strategy checking (i.e. assessing how well a particular strategy works), and double checking, which includes consideration of alternatives.
You may alter (i.e. double check) your sentence before it is assessed by the system, by retrieving it from the dialog box which appears after you have entered your sentence.
It is helpful if you tell the system which type(s) of self-monitoring you use (or indicate the use of none). You may inform the system about your use (or lack of use) of this strategy by selecting "learning strategies" from the STUDENT MENU, and then choosing "Your Use of Strategies".

Self-evaluation involves checking your performance (according to your own measures of accuracy) after completion of the task. This includes evaluation of your ability to perform the task, and your learning strategy use.
You must tell the system how confident you feel about your sentences by indicating this in the dialog box which appears after your input has been entered.
You may indicate your evaluation of your ability and strategy use by selecting "learning strategies" from the STUDENT MENU, and then choosing "Your Use of Strategies".

COGNITIVE STRATEGIES:

Resourcing involves the use of any available references, such as books, dictionaries etc.
In this system you may refer to grammar rules or examples, and compare these to rules and/or examples in other languages (by selecting "question grammar" from the STUDENT MENU), and you may also ask questions about this grammar.
You may access a translation (from "translation") on the STUDENT MENU.
You may refer to the system's representation of the rules known by yourself ("question model"),
You may review the trace of your current or previous interactions (in "interaction" window.)
Finally you may consult notes or summaries made by yourself in the "note-taking" window[4].
You may inform the system about your use (or lack of use) of aspects of this strategy by selecting "learning strategies" from the STUDENT MENU, and then choosing "Your Use of Strategies".

Note taking involves writing down important or key concepts. This may be with reference to the target grammar, comparisons between the target and another language, etc. You may also wish to make notes concerning the use of learning strategies, or aspects of the target rules or exercise that you find difficult, etc.
You may make notes (which will be saved for you by the system) through selection of the item "notes" from the STUDENT MENU. These notes may then be printed if required.
You may inform the system about your use (or lack of use) of this strategy by selecting "learning strategies" from the STUDENT MENU, and then choosing "Your Use of Strategies".

Summarization of information may be undertaken in the note-taking windows available through selection from the STUDENT MENU. (See *note taking*.)
You may inform the system about your use (or lack of use) of this strategy by selecting "learning strategies" from the STUDENT MENU, and then choosing "Your Use of Strategies".

Grouping of information is a useful aid to learning. It may be through ordering, classifying or labelling material according to content. The important factor is that this grouping of information is meaningful to you.
In this system separate note-taking windows are provided to assist your grouping of material.
You may inform the system about your use (or lack of use) of this strategy by selecting "learning strategies" from the STUDENT MENU, and then choosing "Your Use of Strategies".

Deduction involves the conscious application of rules (either learned rules or rules developed by yourself).
You may request descriptions of rules by selecting "question grammar" from the STUDENT MENU.
You may inform the system about your use (or lack of use) of this strategy by selecting "learning strategies" from the STUDENT MENU, and then choosing "Your Use of Strategies".

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4 Recall that a dictionary is also planned.

Inferencing is the use of any available clues to predict usage of aspects of the language of which you are unfamiliar (or to guess meanings in cases of doubt).
In this system you may actively pursue inferencing techniques by requesting examples instead of explicit rules, or you may explicitly generalise rules already acquired or explained by the system, to include other cases. (This could in some cases lead to correct production, and others, incorrect.) These possibilities may be achieved through selection of the option "question grammar" from the STUDENT MENU.
You may inform the system about your use (or lack of use) of this strategy by selecting "learning strategies" from the STUDENT MENU, and then choosing "Your Use of Strategies".

Substitution involves the selection of an alternative structure to replace one about which you are unsure, eg. "Não os quer comprar" instead of "Não quer comprá-los". (Substitution of some learning strategies by more effective ones may also be useful.)
You may inform the system about your use (or lack of use) of this strategy by selecting "learning strategies" from the STUDENT MENU, and then choosing "Your Use of Strategies".

Translation here refers to more or less word-for-word translation. This may be useful in cases of real difficulty, but usually leads to untarget-like production.
You may receive a translation by selecting "translation" from the STUDENT MENU.
You may inform the system about your use (or lack of use) of this strategy by selecting "learning strategies" from the STUDENT MENU, and then choosing "Your Use of Strategies".

Transfer is here defined as the use of rules from one of your background languages to facilitate production in the target language.
Such transfer may be either positive or negative - i.e. the rules you use may be the same or different in the two languages.
Transfer can be either conscious or unconscious.
It is useful to be aware of when languages coincide and when they do not.
The system will advise you of cases of negative transfer as they arise, and suggest possibilities for positive transfer if appropriate when you are experiencing difficulty.
You may find out more about transfer in relation to the languages you know, by selecting "question grammar" from the STUDENT MENU.
You may inform the system about your use (or lack of use) of this strategy by selecting "learning strategies" from the STUDENT MENU, and then choosing "Your Use of Strategies".

SOCIAL STRATEGIES:

Questioning involves asking for explanations, verifications or examples.
In this system you may use questioning with reference to the target grammar, relationships between the target and other languages (by selecting "question grammar" from the STUDENT MENU).
You may use questioning with reference to learning strategies (by selecting "learning strategies" from the STUDENT MENU).
You may question the contents of the system's representation of your own knowledge and beliefs (by selecting "question model" from the STUDENT MENU).
You may inform the system about your use (or lack of use) of the various aspects of this strategy by selecting "learning strategies" from the STUDENT MENU, and then choosing "Your Use of Strategies".

Cooperation implies the idea of working with others.
Here you will be working together with the system in an attempt to clarify your knowledge and beliefs (both to the system and to yourself).
You may state your beliefs about your learning strategy use at any time, or negotiate your future use of learning strategies, through selecting "Your Use of Strategies", after choosing "learning strategies" from the STUDENT MENU. You may also ask questions.
You may assert your confidence level in a particular sentence by using the dialog box which appears after you have entered your input.
You may discuss grammar (target only, or transfer-related) by selecting "question grammar" from the STUDENT MENU.
You may discuss the system's representations of your beliefs by selecting "question model" from the STUDENT MENU.
The system will initiate discussion on any of the above topics if it requires information, and it is helpful if you cooperate with such requests (as this ultimately results in a more accurate representation of your knowledge in the system, which will in turn enable the system to anticipate your requirements more effectively).
The system will cooperate with all your requests for information.

2. *Strategies not traced by the system:*

This window presents other learning strategies sometimes used by students. The information is presented to make you aware of a wider range of possibilities for strategy use, but these learning strategies are not dealt with by this system as it is not the most appropriate context for their consideration.

METACOGNITIVE STRATEGIES:

Directed attention is an advance decision to attend to the task, i.e. ignore any potential distractions.
Selective attention is an advance decision to attend to particular circumstantial details or aspects of the language input which facilitate performance.
Self-management involves the understanding of the types of situation which facilitate successful performance, and the arrangement for such conditions to be available.
Problem identification is the explicit identification of the main point to be solved, or the identification of a specific aspect of a task which impedes its execution.

COGNITIVE STRATEGIES:

Repetition simply involves repeating a language chunk. This may be a word or a whole sentence, etc.
Elaboration involves the relation of new information to what is already known, or the relation of separate parts of new information to each other. Personal relations may also be made to new information, eg. experiential or academic knowledge, imagery, etc.

SOCIAL STRATEGIES:

Self-talk results in anxiety reduction through the use of personal mental techniques which increase your confidence.

Self-reinforcement is the provision of rewards for successful task completion, in order to increase motivation.

Appendix F

Definitions of negotiation

Definitions of Negotiation
Key: A = Individual; B = individual; C = Joint (A + B)

A: The process of bringing two divergent veiwpoints towards agreement
B: Amicable agreement or successful confering
C: successful confering between divergent viewpoints

A: Negotiation =
two sides approaching a problem from differing points of view and agreeing on a compromise that is acceptable to both parties.
B: **Negotiation:** means to talk taking all concerned parties' points of view into consideration with a view to arriving at a mutually acceptable agreement.
C: **Negotiation:** discussions to reach an acceptable agreement.

A: Negotiation is when individuals, or teams, start from different opinions or positions, and make compromises to achieve a solution which is acceptable to all parties. The negotiation is the actual discussion which takes place before the compromise is achieved.
B: Negotiation is a process by which people attempt to reach agreement over an issue. If successful the process allows the people involved to arrive at a conclusion accepted by the majority.
C: Negotiation is a process by which people starting from different positions attempt to reach agreement over an(y) issue(s). For the process to be successful, all parties will make compromises to achieve a solution which is acceptable to the majority.

A: Negotiation
Where two or more people get together to discuss something of interest to all parties and come to a decision that satisfies all.
B: Finding a settlement acceptable to all the parties in dispute.
C: Give and take on all sides to reach a satisfactory conclusion.

A: Negotiation is what takes place between individuals or companies etc in order to settle disputes, agree contracts etc etc.
B: To try to come to agreement by means of discussion.
C: After negotiation we decided mine was more concise.

A: Negotiation is the process of resolving possible conflicts (clash of interests) in order to reach a common goal. It is usually done through non-violent means like discussing. It often involves compromises on behalf of those concerned. Example of negotiations are settling territory disputes between countries after a war through series of meetings.

B: Negotiation: two or more parties reaching a common agreement on the basis of a process of offer and counter-offer. Another important element of negotiation is explanation of each party's positions.

C: Negotiation is a process whereby two or more parties attempt to reach common agreement on issues, where these issues are of relevance to the successful completion of each party's goals. The process is realised as a series of statements of position. Sucessful negotiation would require these sucessive statements to move closer together, often through compromise (offering a position less favorable to the offerer, but more favorable to the other). However, in some cases the offer could actually be an improvement for both parties. Offers need not be in the same vein as the initial offer. Negotiation is usually done through non-violent means like discussion. Example of negotiations are settling territory disputes between countries after a war through series of meetings, or agreeing on a price in trade.

A: Negotiation
When two or more people meet to come to an agreement about various things.

B: Two sides with different opinions meeting to discuss their opinions in the hope of coming to a solution.

C: If you negotiate it does not automatically mean that an agreement will be reached.

A: Negotiations: the process by which two or more people seek to reach a set of circumstances, and/or a contract, acceptable to each of them.

B: "Negotiations" This term is normally used to describe the process by which parties reach an acceptable solution or outcome to a situation where a variety of interests arise.

C: "It seems we agree"

C: Negotiation
The process of attempting to achieve a settlement between two or more parties whose original aims differ.

A: Negotiation:-
A process intended to resolve a situation.

A: 2 or more parties discussing a problem/topic, trying to obtain something beneficial to themselves whilst understanding others' viewpoints. Usually resulting in an amicable agreement benefitting all parties to some extent.

A: Negotiation:
Attempt to reach agreement by two or more parties on a topic of common interest. This is a process involving flexibility on both sides, where compromise, rather than strict adherance to principle, is more likely to lead to a successful agreed outcome.

A: Agreeing to settle differences by talking, listening, discussing and bargaining.

A: Discussions aimed at meeting a common conclusion

A: The process (or is it an art?) by which two or more people attempt to come to some form of agreement which is mutually acceptable to the parties involved.

A: a number of parties moving from their fixed (different) standpoints towards a mutually acceptable solution.

A: Two points of view discussed until a compromise is reached which is acceptable to both parties is my personal definition.

A: A meeting between two "parties" in order to discuss a situation which is relevant to both parties, and by which a solution or an agreement can be mutually made as a result of this discussion.

A: "What's it worth?"

A: A group of participants starting form diverse viewpoints arriving at a consensus position.

A: contact between individuals in order to reach a "win win" situation.

A: "an attempt to reach agreement through discussion"

A: From the mother of a teenager:
Patiently explaining why x, w, y or z is not a good idea, him saying 'Oh Mum' then doing it anyway!!

Appendix G

Independent evaluation of an interaction with Mr. Collins

The following is an independent assessment of the interaction given in chapter 5. This evaluator was approached because of her interest in metacognitive issues in second language acquisition, learning strategies, experience in CALL, and experience in the development of materials for foreign language learning. However, she was not directed as to what to include in her evaluation.

Evaluation: Interaction with Mr. Collins (student B2).

Evaluator: Elspeth Broady.
The Language Centre, University of Brighton.

Background: Principal Lecturer in:
Second Language Acquisition, French, Media-Assisted Language Teaching.

Author of:
Broady. E. & U. Meinhof (1994) Tele-Textes. Video and activity book. Oxford University Press.
Broady. E. & U. Meinhof (1995) Tele-Textes. CD-ROM. Oxford University Press.
Broady, E. & M.M. Kenning (1996) (eds.) Promoting Learner Autonomy in University Language Learning. Centre for Information on Language Teaching.
Broady. E. & M. Shade (1996) Tele con textos. Video and activity book. Oxford University Press.
Broady. E. & M. Shade (in press) Tele con textos. CD-ROM. Oxford University Press.
Broady, E. & C. Carpenter (in press) En route vers l'Europe. Course book and cassettes.

One of the immediate advantages of the type of interaction generated by this system is that it can discretely challenge the learner's perspective on their own learning. The result is not to oblige learners to change their working style or lock them into a particular way of working, but rather to encourage them to reflect on what they are doing and how they feel about it.

Language learners often suffer anxiety in relation to grammatical rules

that are not transparent to them and tend to lose confidence and underestimate what they have understood. This system invites learning dialogue, encourages learners to build up and test their understanding and offers alternative support that can serve to 'unblock' those who get stuck. This is particularly important when learners are developing explicit control over grammatical forms: as Fortune (1992) has found, learners recognise the value of inductive approaches to grammar practice, but feel insecure if they cannot confirm their hypotheses immediately. Most learners, it seems, would probably want to attack grammatical exercises combining both inductive and deductive approaches.

Further, in presenting the learner with a neutral 'confidence' measure, this system can serve to challenge learners' negative perceptions, as was the case here. What is particularly interesting about the interaction here is how the 'challenge' leads to the learner assessing her own performance rather more precisely and identifying for herself an explicit goal ("I can't do them quickly enough").

Developing this kind of metacognitive skill in learners requires learning dialogue focused on a particular task in hand: this is not easy to accomplish in a large class of learners all with different needs, although dialogue with peers can go some way to alleviating this. But then the neutrality of the system probably offers an advantage here: learners, particularly in institutional classes, tend not to want to acknowledge their own competence in the company of peers, nor appear to be over-enthusiastic. In this sense, the system's neutral feed-back can act as a powerful trigger. Apart from encouraging those who are less confident to define the nature of their self-evaluation, it could also nudge those who get a high score by 'just guessing' into trying to strengthen their understanding.

Learners very quickly get impatient if they have to go through stages of work that seem irrelevant. The advantage of this system is that there is no obligatory path through the different types of learner support (be it declarative or procedural): they are there for learners to consult, but advice is offered to help the learner perceive the interaction as a well structured learning task. Further, because of the dialogic nature of the support, there is a sense that the feed-back is individually targeted. This system has a lot to offer as a self-study support, maintaining learner focus, while offering different perspectives on the learning task and promoting learner reflection.

Reference

Fortune, A. (1992) 'Self-study grammar practice: learners' views and preferences' ELT Journal 46/2: 160-171.